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Seattle Tolt Water Supply Mixed Asbestiform Removal Study. Appendix D

Seattle Dept of Water, WA Water Quality Div

Prepared for

Municipal Environmental Research Lab, Cincinnati, OH

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Municipal Environmental Research
Laboratory
Cincinnati OH 45268

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Seattle Tolt Water Supply Mixed Asbestiform Removal Study

Appendix D

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16. ABSTRACT For 1 1/2 years the Seattle Water Department conducted direct filtration pilot plant studies at the Tolt Reservoir, obtaining data on techniques to remove amphibole and chrysotile asbestos from drinking water. Research showed that filtered water turbidity should be 0.1 ntu or lower in order to effectively remove fibers. Flocculation was necessary but sedimentation was not. Amphibole fibers are more readily removed than chrysotile, but both types could be reduced to below detectable limits or to not statistically significant counts by treatment with alum, lime and a filter aid (nonionic or anionic polymer); or alum, cationic polymer and a filter aid; or cationic polymer and a filter aid. Asbestos fiber content of filtered water increased sharply when filtered water turbidity rose above 0.1 ntu because of filtration rate changes, interruption of chemical feed, or turbidity breakthrough associated with the end of the filter run. Asbestos fibers in the concentrations encountered in this study (raw up to 20 x 10^6 f/L, filtered down to 0.01 x 10^6 f/L) can not be detected by a turbidimeter; however, the association of rising fiber counts and turbidities in filtered water would enable a plant operator to estimate fiber removal by observing turbidity if the filter was operated in the manner done in this work. This appendix lists flow schematics tested during the pilot study and contains plots of headloss and turbidity vs. time for each filter run.

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SEATTLE TOLT WATER SUPPLY
MIXED ASBESTIFORM REMOVAL STUDY

Appendix D

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Grant No. 804422

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FOREWORD

The Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first stop in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems for the prevention, treatment, and management of wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, for the preservation and treatment of public drinking water supplies, and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research; a most vital communications link between the researcher and the user community.

This report and its appendixes present the results of pilot plant filtration research on the removal of naturally occurring asbestiform fibers from a protected mountain water source. This appendix contains a listing of the flow schematics tested during the pilot study and plots of headloss and turbidity vs. time for each filter run.

Francis T. Mayo, Director
Municipal Environmental Research
Laboratory

ABSTRACT

Pilot plant research conducted during 1977 and 1978 demonstrated that both amphibole and chrysotile asbestos can be removed using direct filtration techniques at filter loading rates as high as 10 gpm/ft^2. Since asbestos fibers, especially chrysotile, were found to be quite sensitive to changes in the treatment process, vigilant control over chemical additions and finished water turbidity is a necessity. During the study, engineering data were also obtained for making cost estimates for construction and operation of a 100 MGD granular media filtration plant.

Appendix D-1 contains a listing of the flow schematics tested during the pilot study and Appendix D-2 contains plots of headloss and turbidity vs. time for each filter run.

This report was submitted in fulfillment of Grant No. 804422 by the Seattle Water Department under the sponsorship of the U.S. Environmental Protection Agency. This report covers a period from May, 1976 to November, 1978 and work was completed March, 1979.

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D-2	Plots of Headloss and Turbidity vs. Time for Each Filter Run.	4

NOTES

Each plot has certain basic information contained on it which may be useful in referencing the main report or appendixes.

1. The raw water turbidity (NTU) for the filter run is listed as "RAW WATER TURB = X.XX".

2. The run number is listed at the top of each plot. Except for the first twelve runs, run numbers ending in the letters F, C, and M indicate that a filter column with a certain type of filter media was used:

   F - indicates dual media with fine coal.
   C - indicates dual media with coarse coal.
   M - indicates mixed media with MS-6 sand.

   The first twelve runs and all run numbers without a letter attached were performed on the Waterboy pilot plant filter.

3. To determine the flow schematic that was used for the run of interest, a letter designating the schematic is also included on the plot, i.e., "Schematic A". The various schematics used may be found in Appendix D-1.

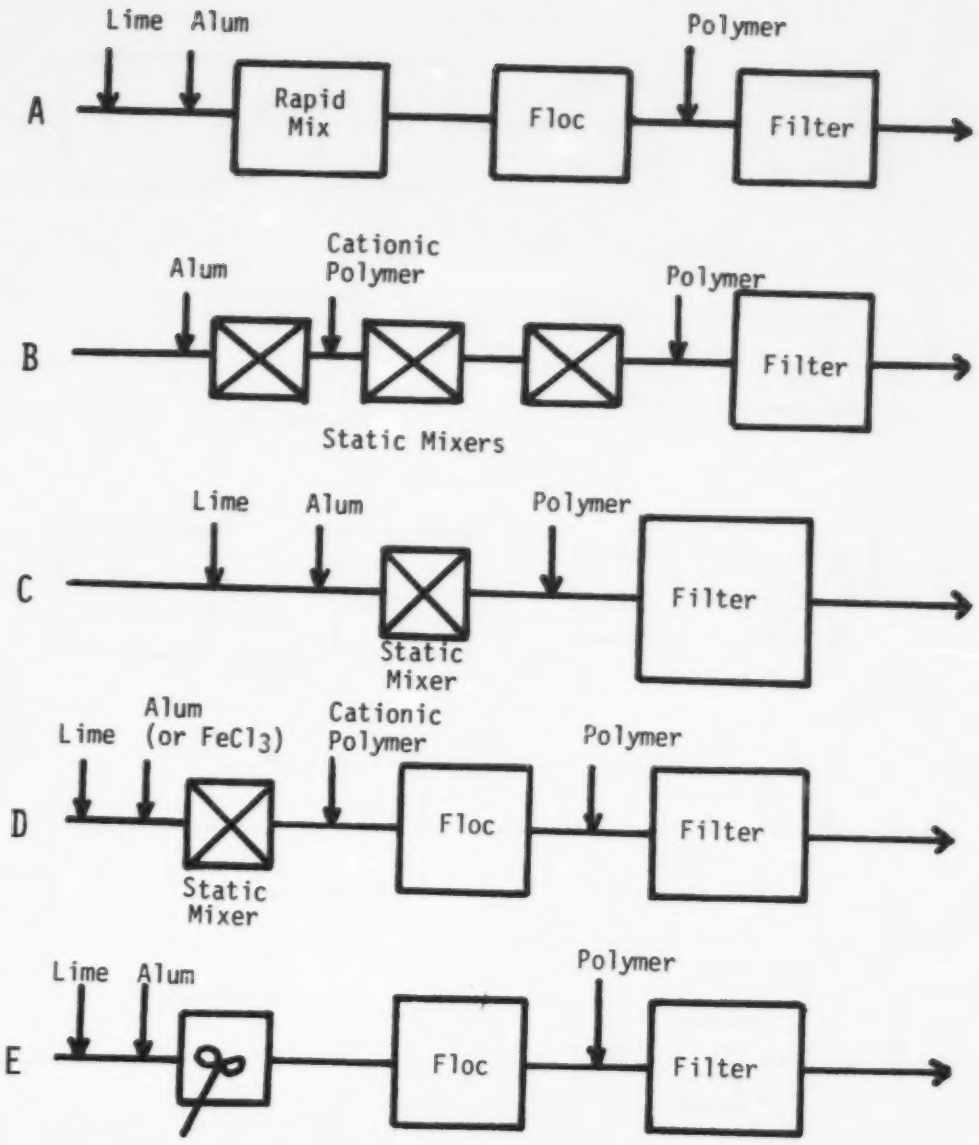

Figure D-1. Listing of flow schematics tested during pilot study.

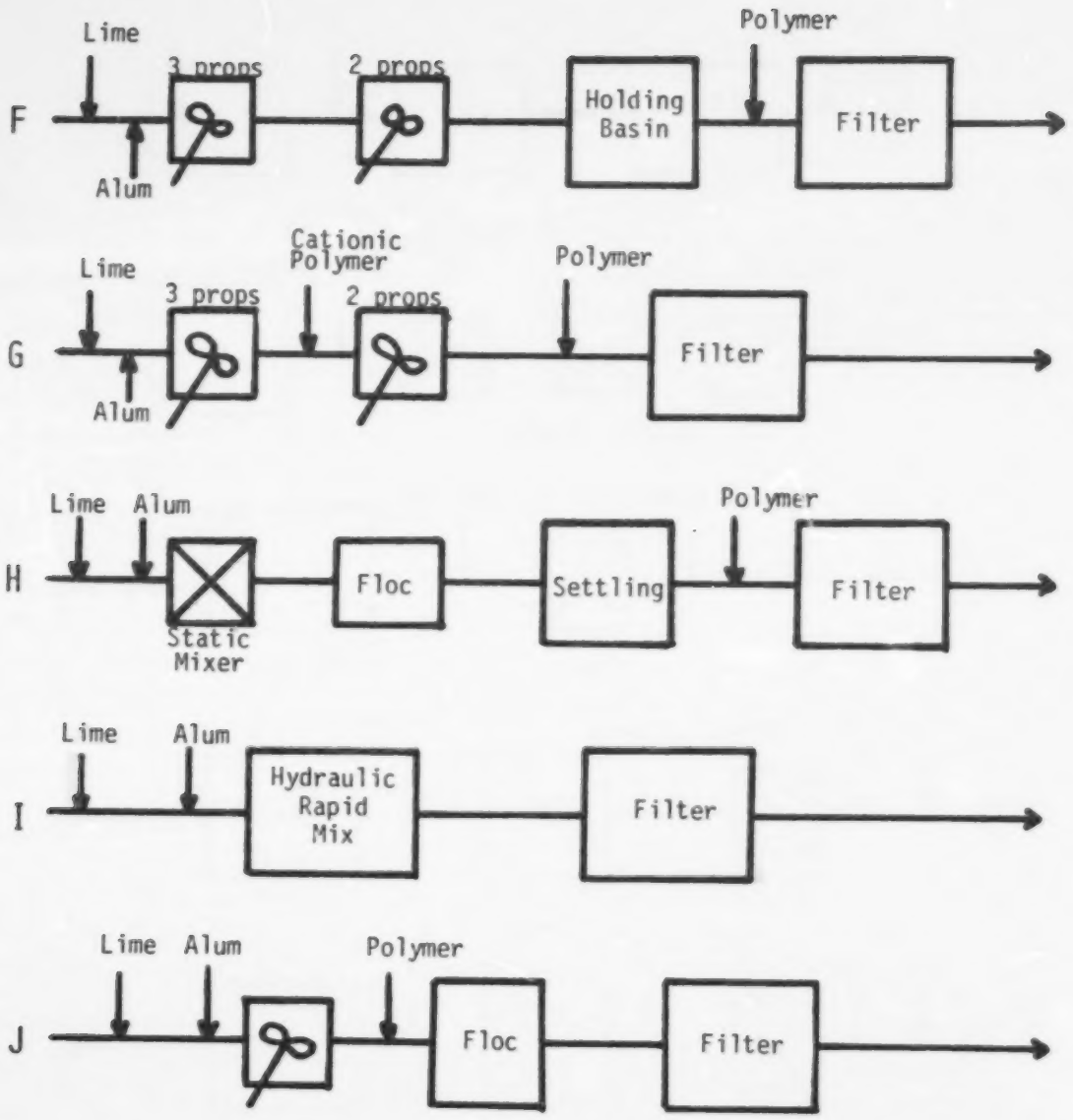

Figure D-1. Listing of flow schematics tested during pilot study.

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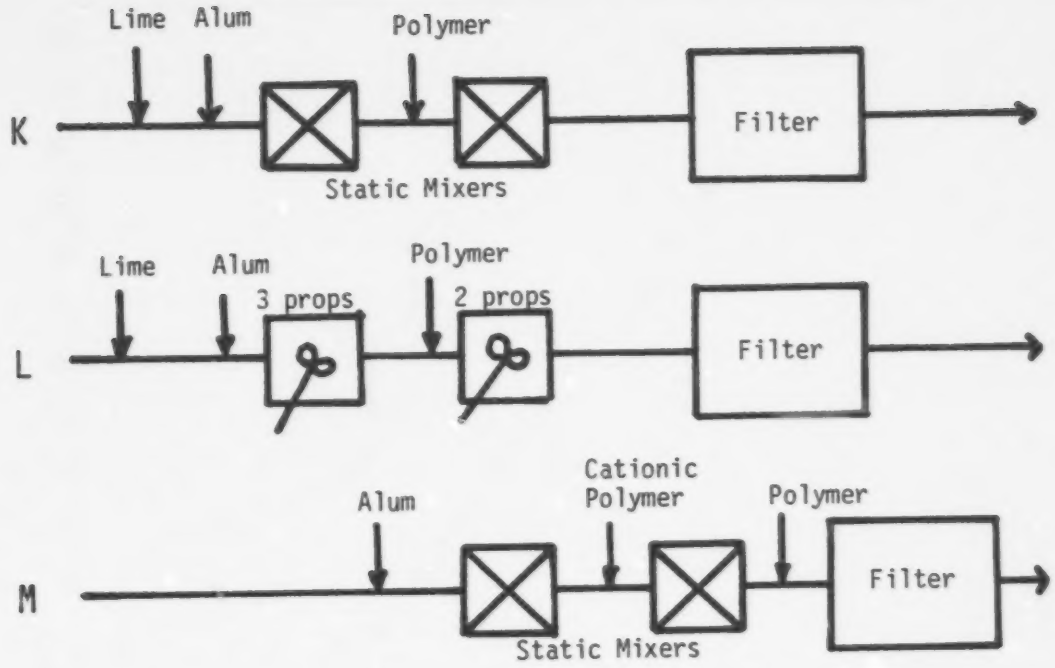

Figure D-1. Listing of flow schematics tested during pilot study.

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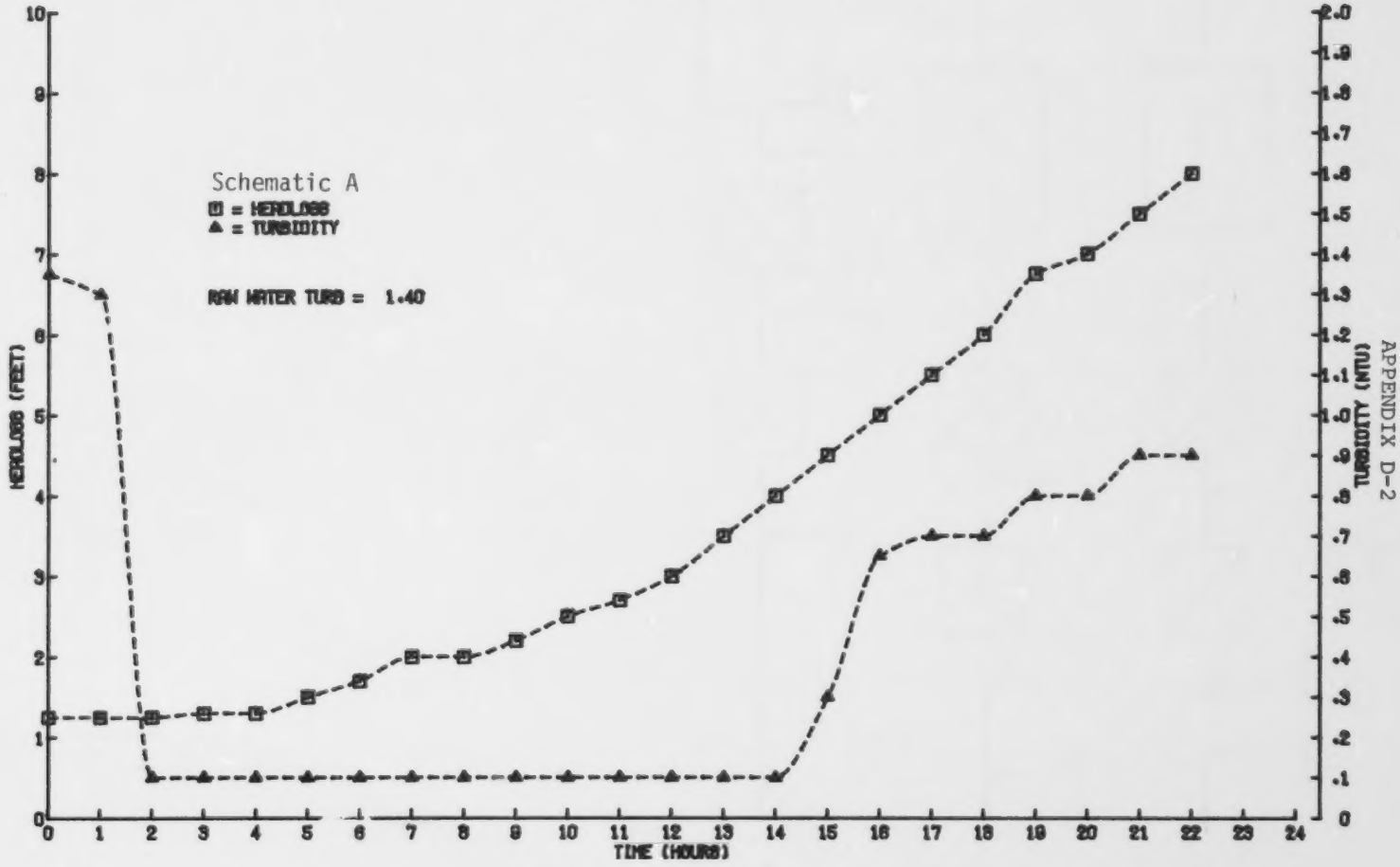
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 4A



HEADLOSS AND TURBIDITY
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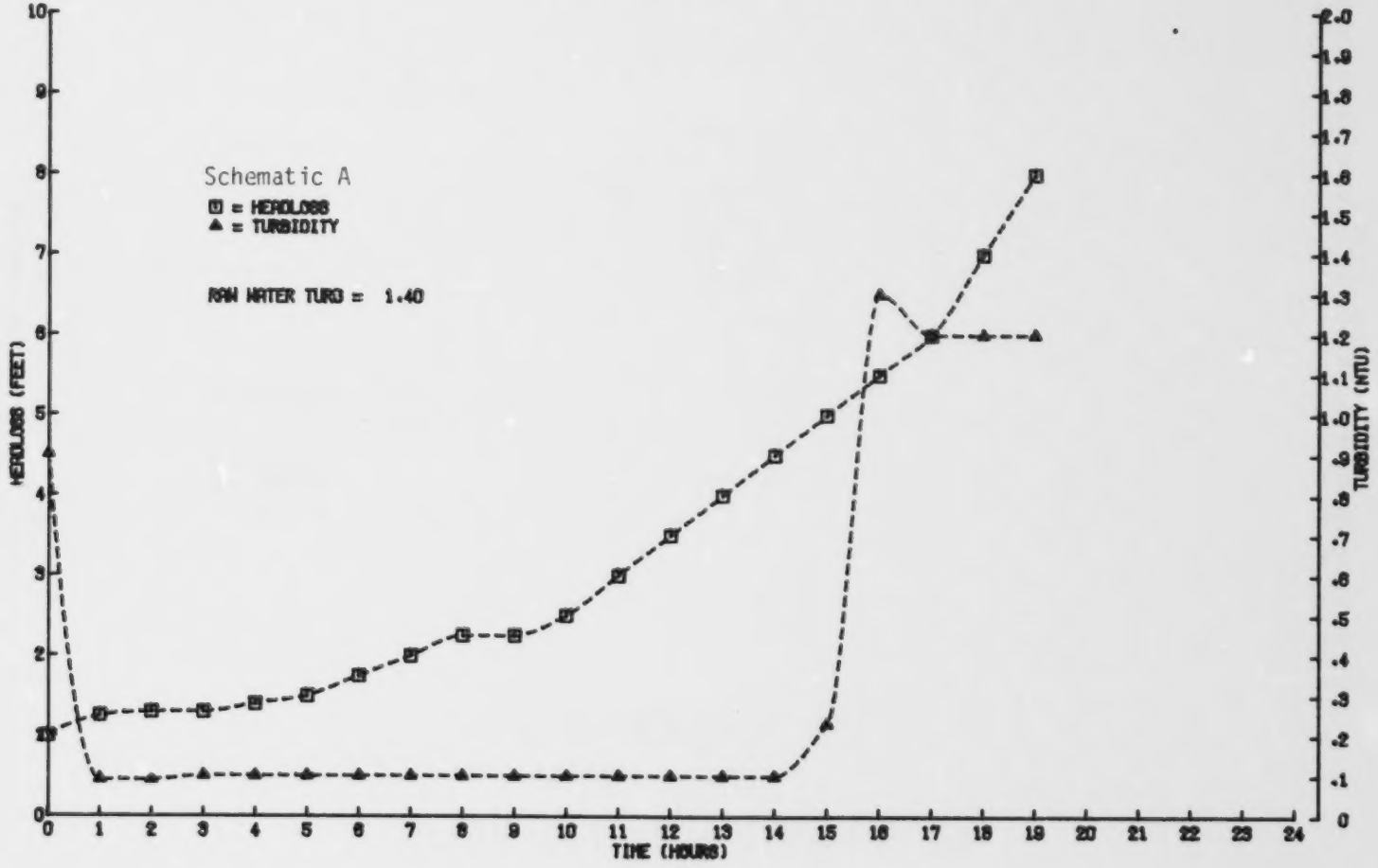
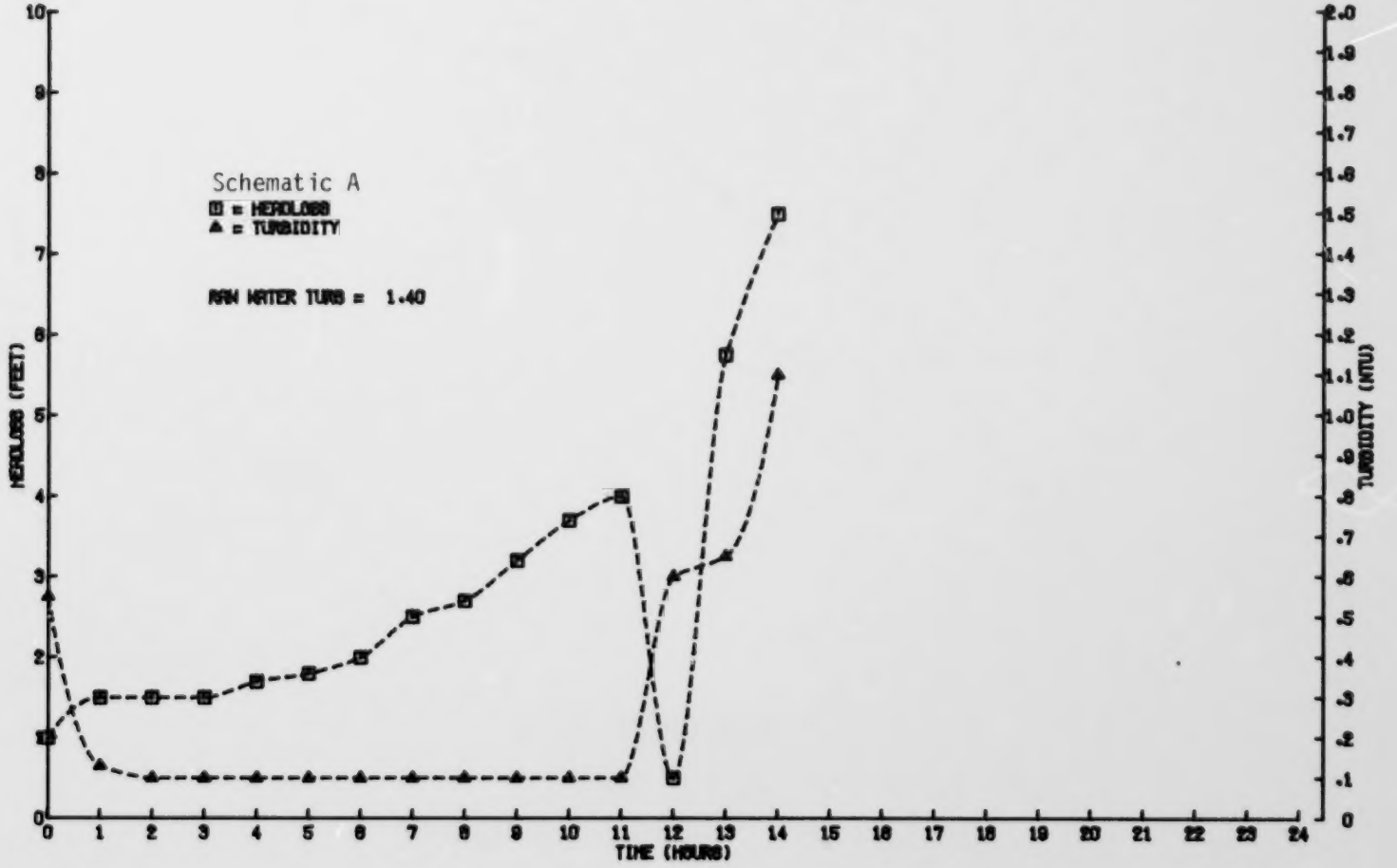
RUN NUMBER 4B



HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 4C



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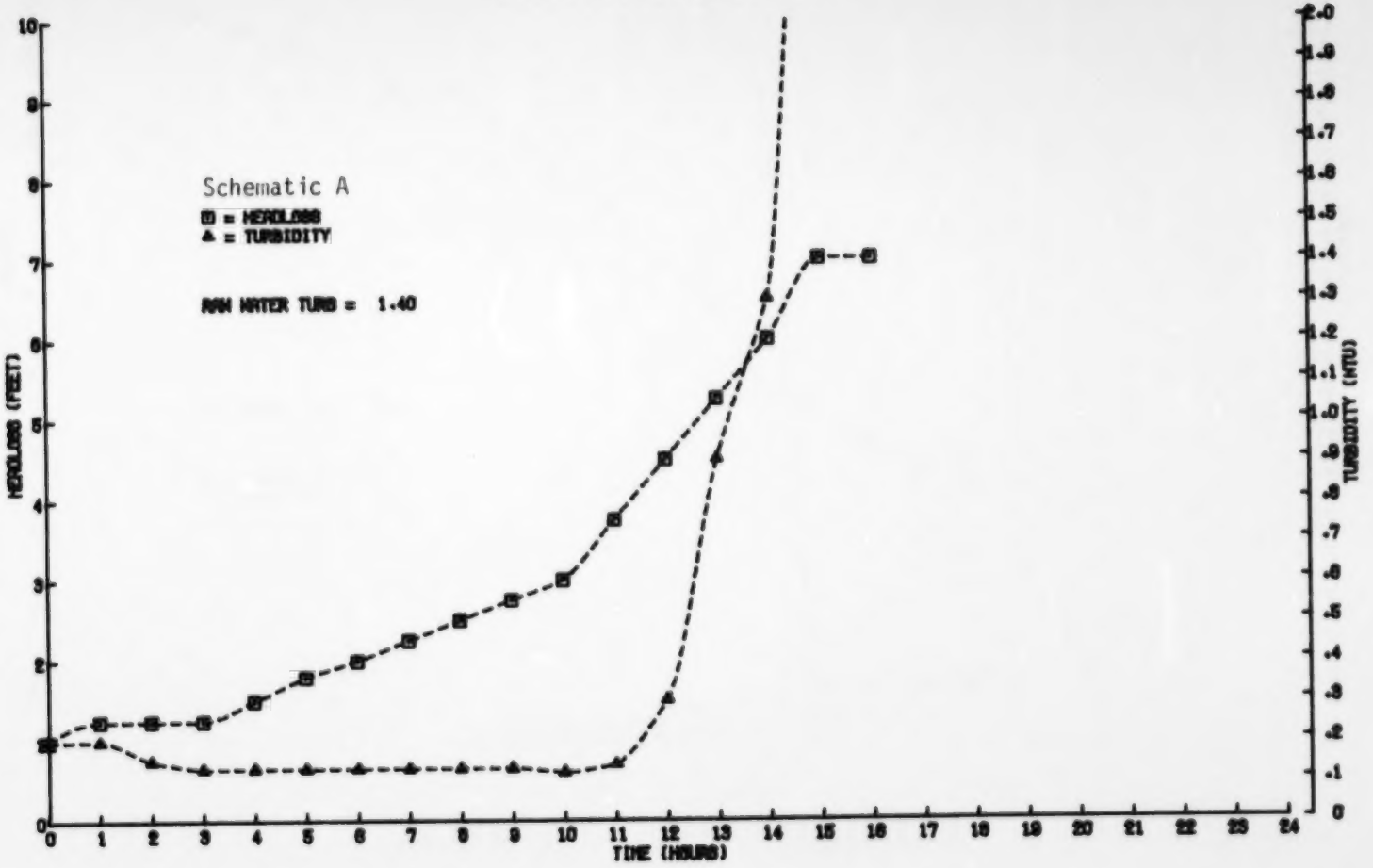

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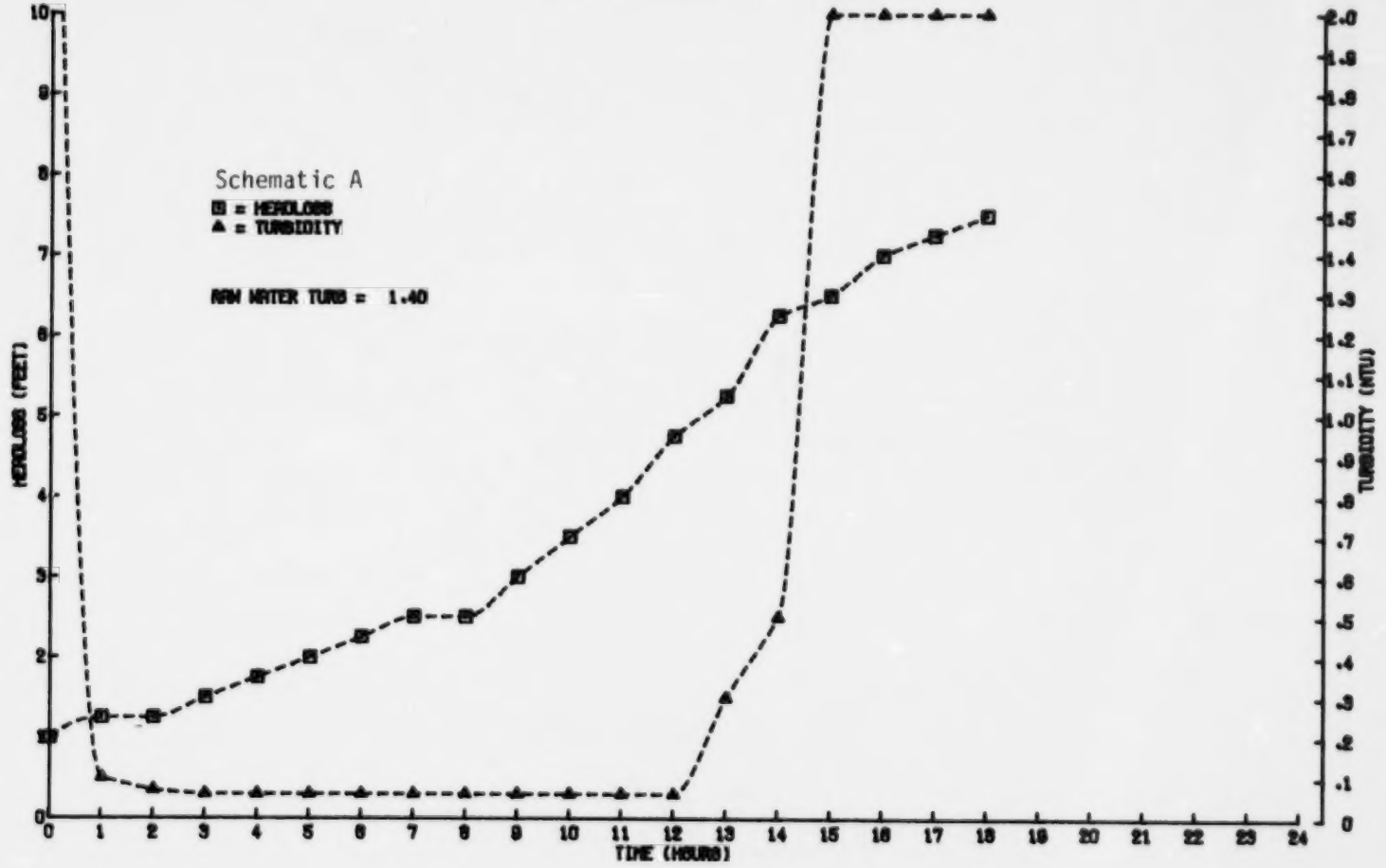

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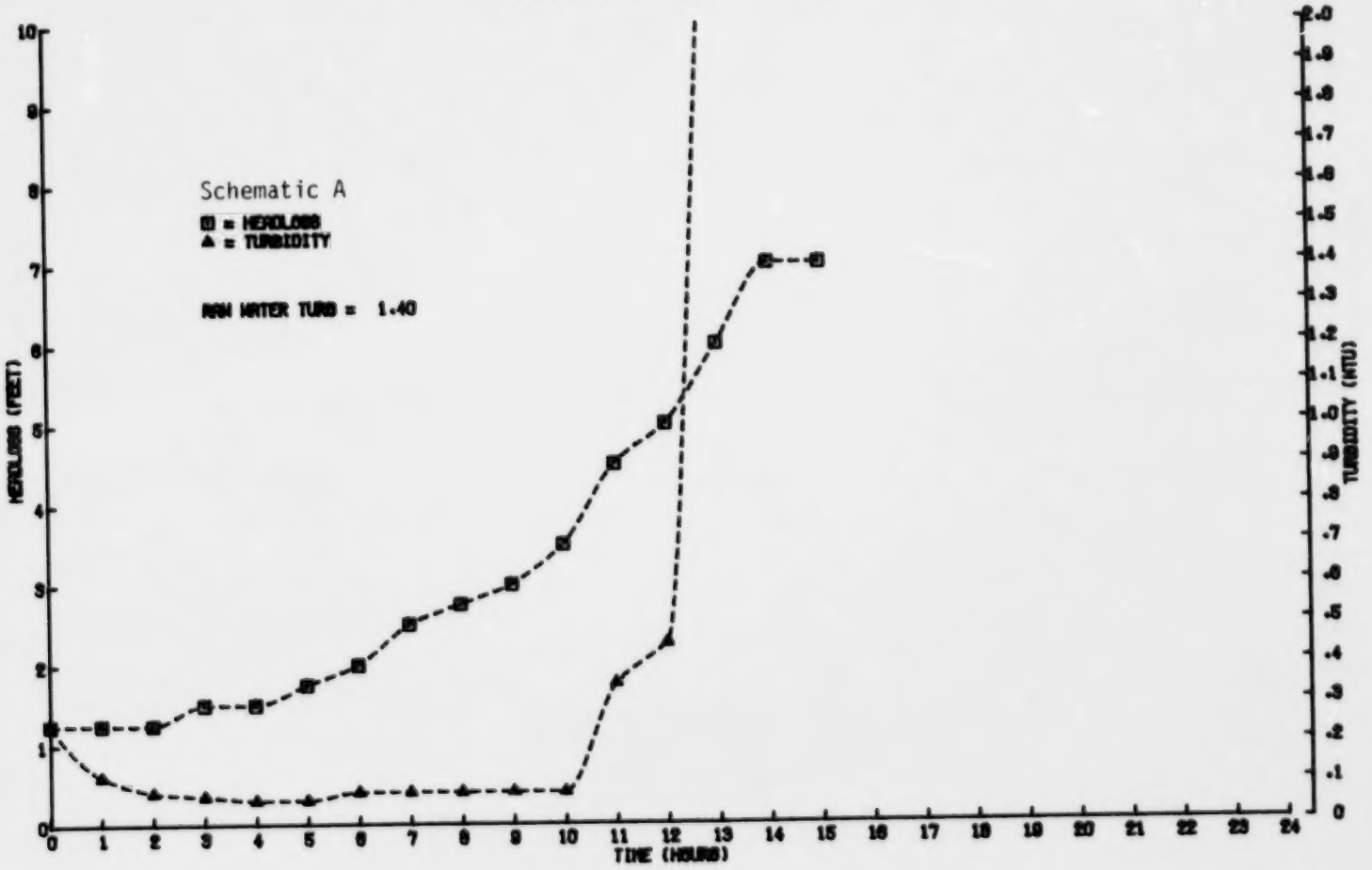

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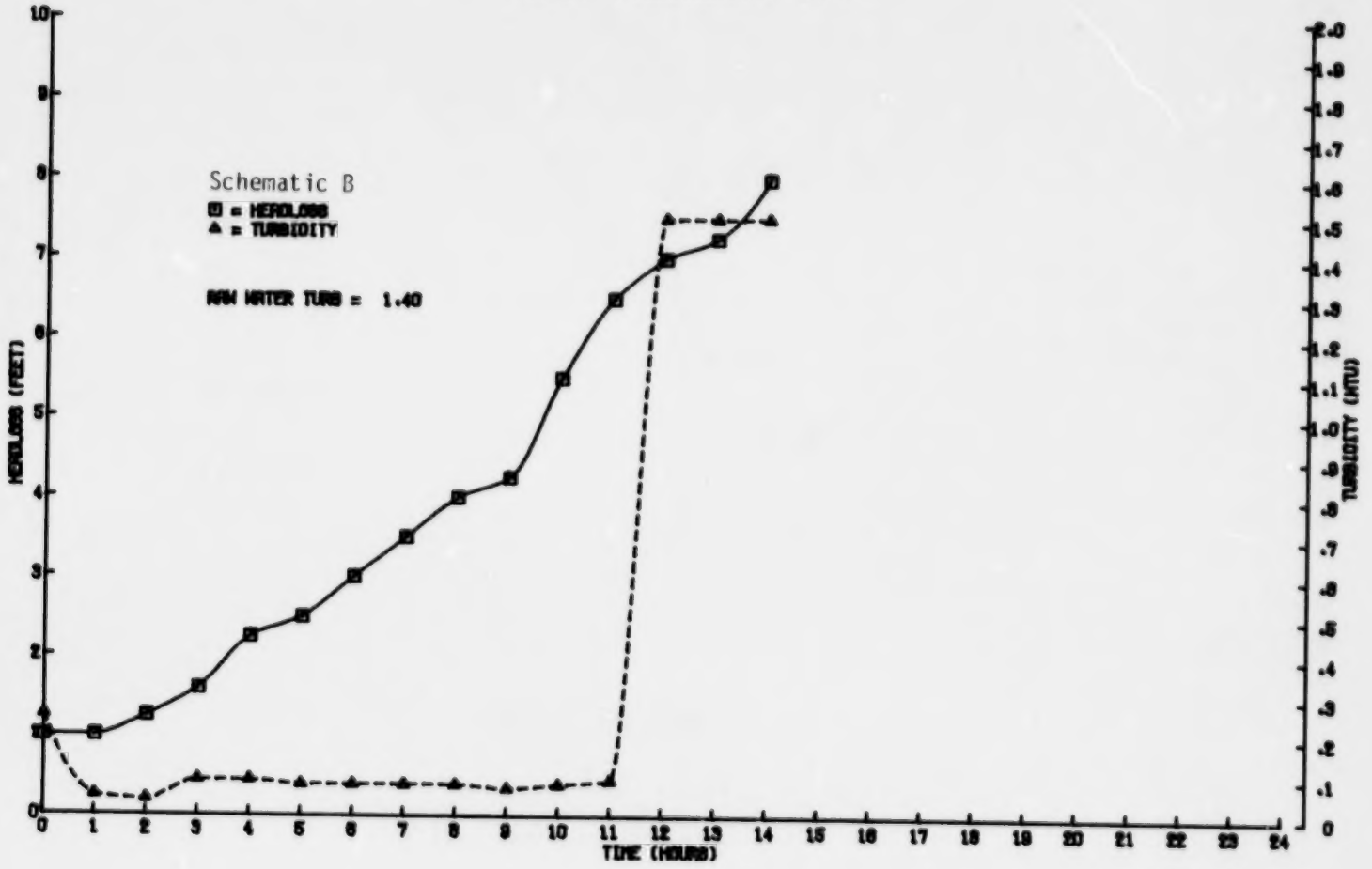

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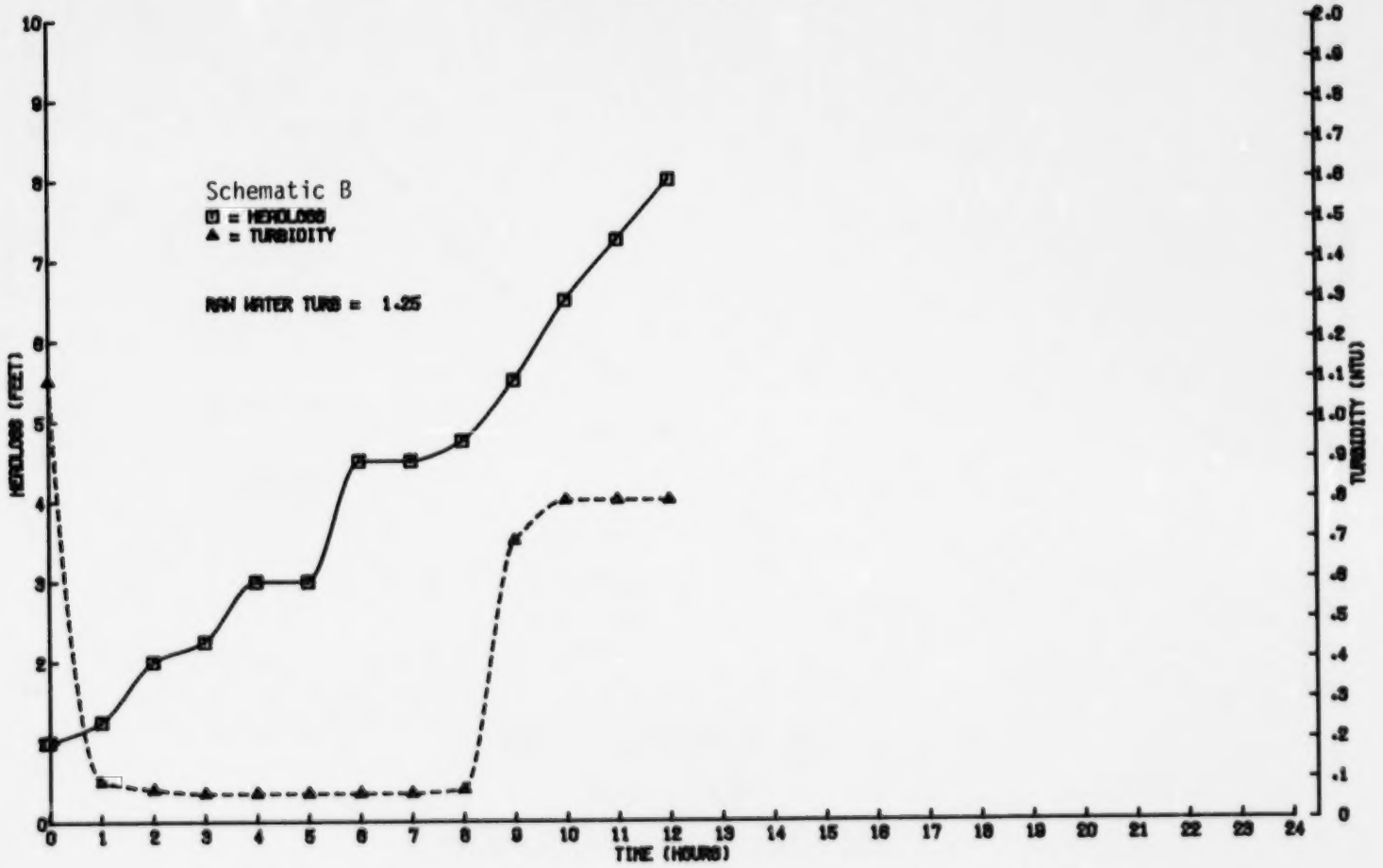

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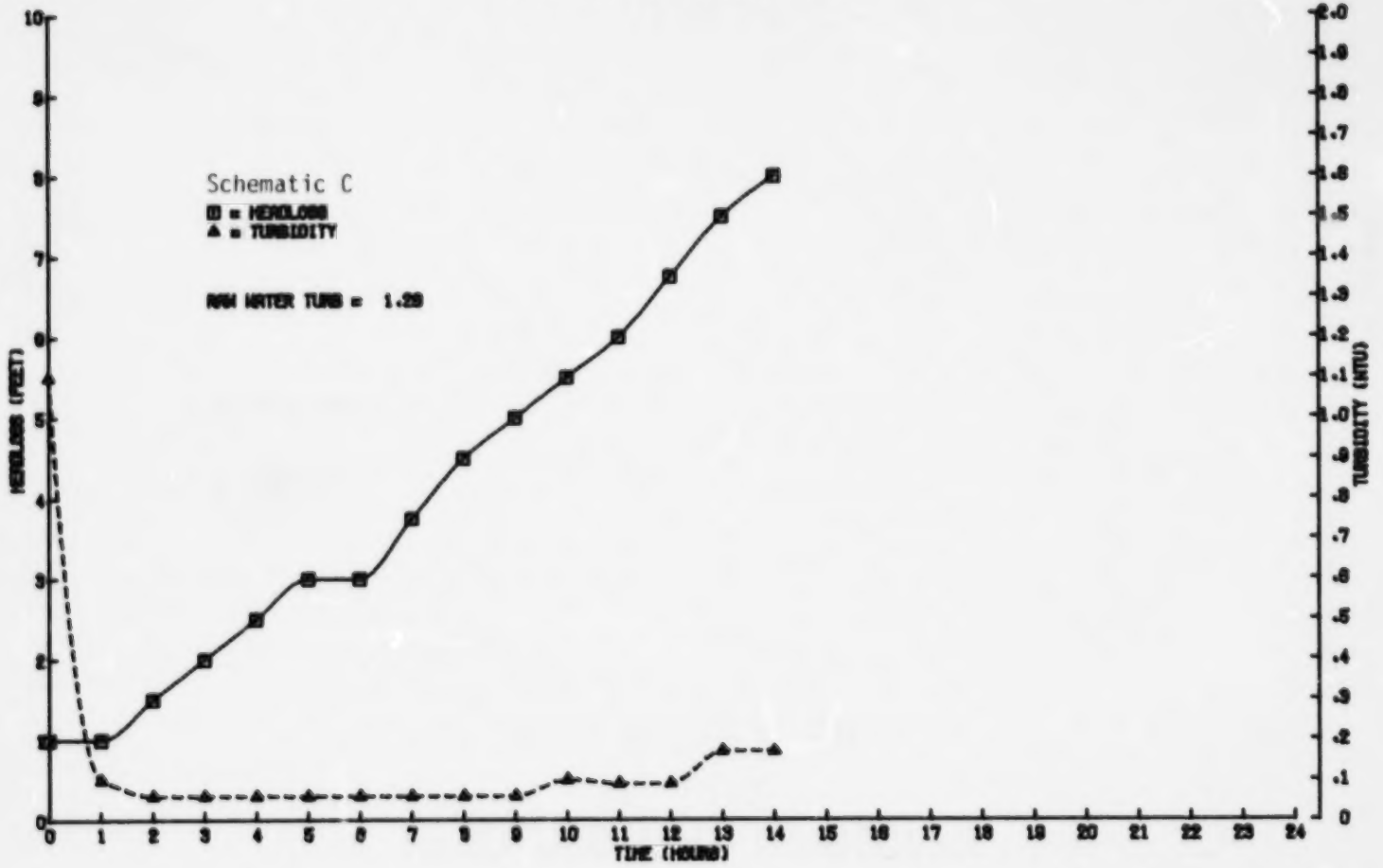

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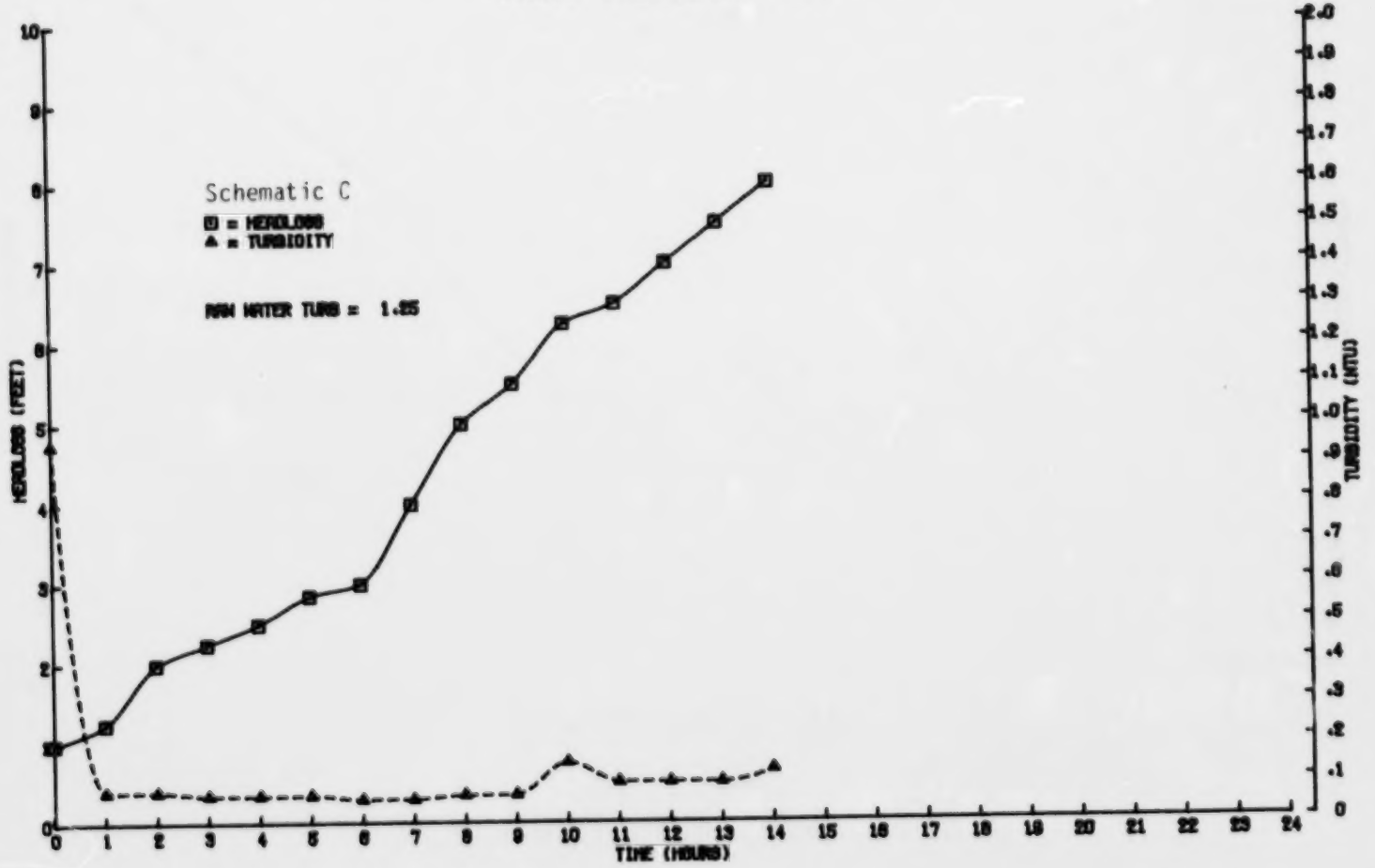

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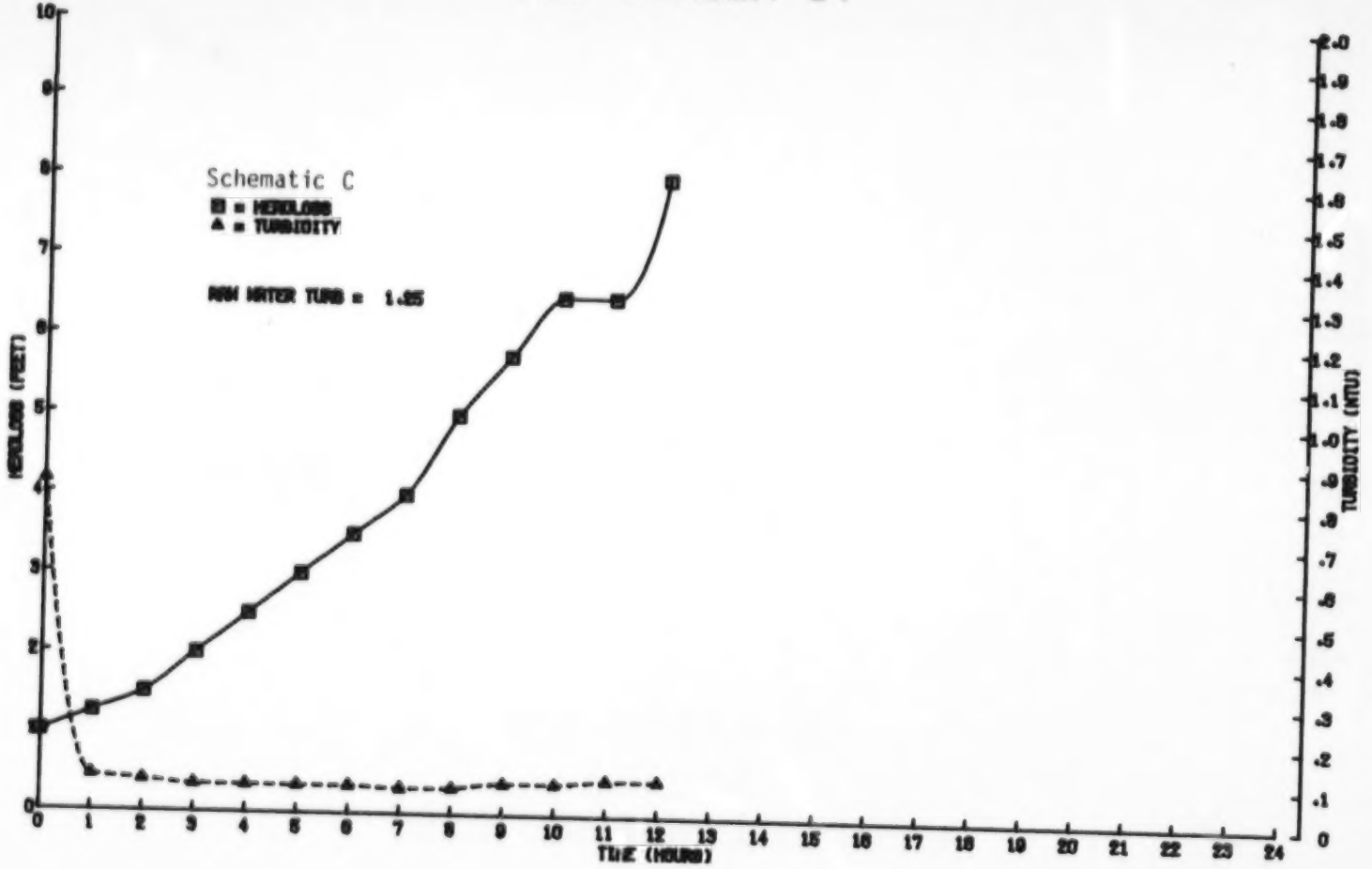

HEADLOSS AND TURBIDITY
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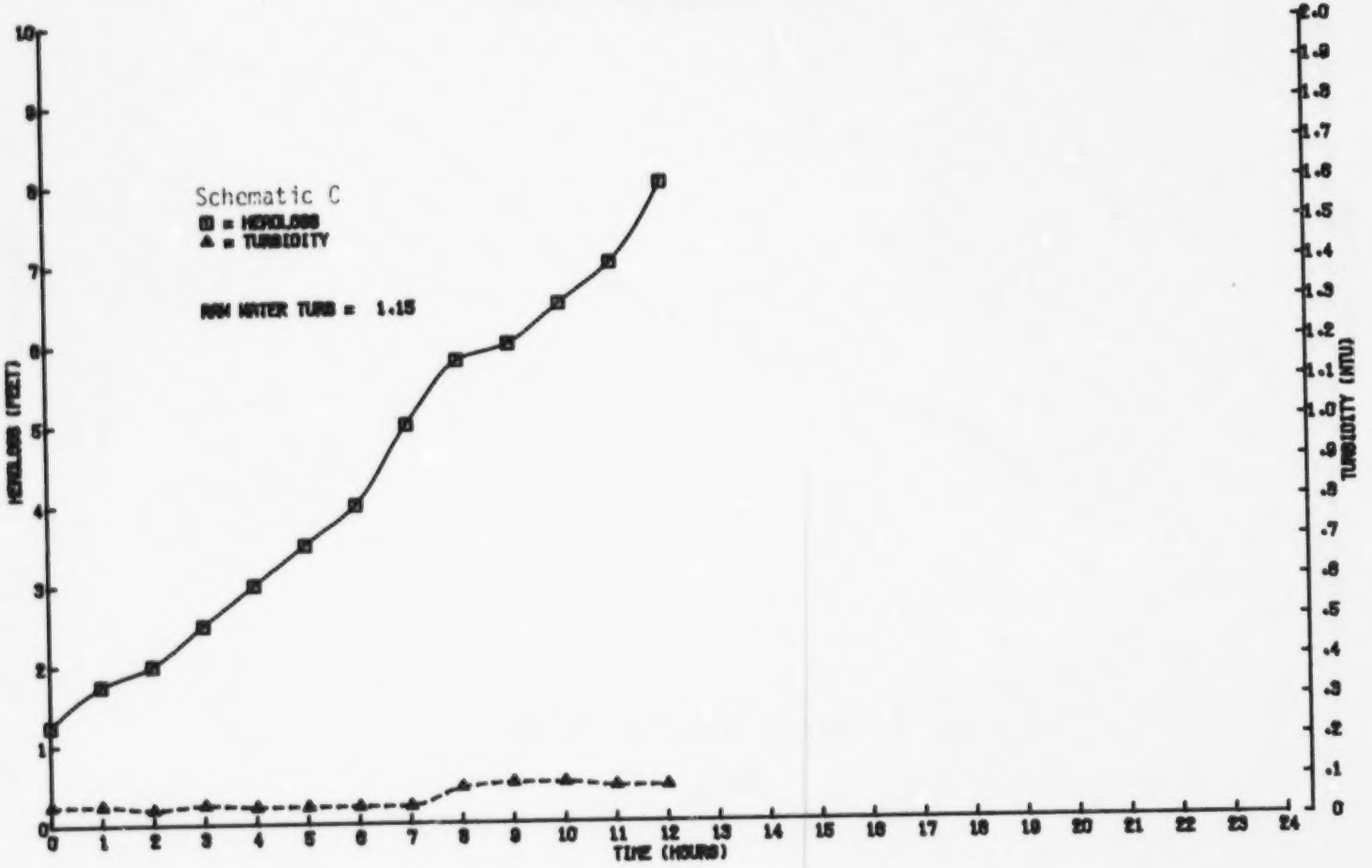

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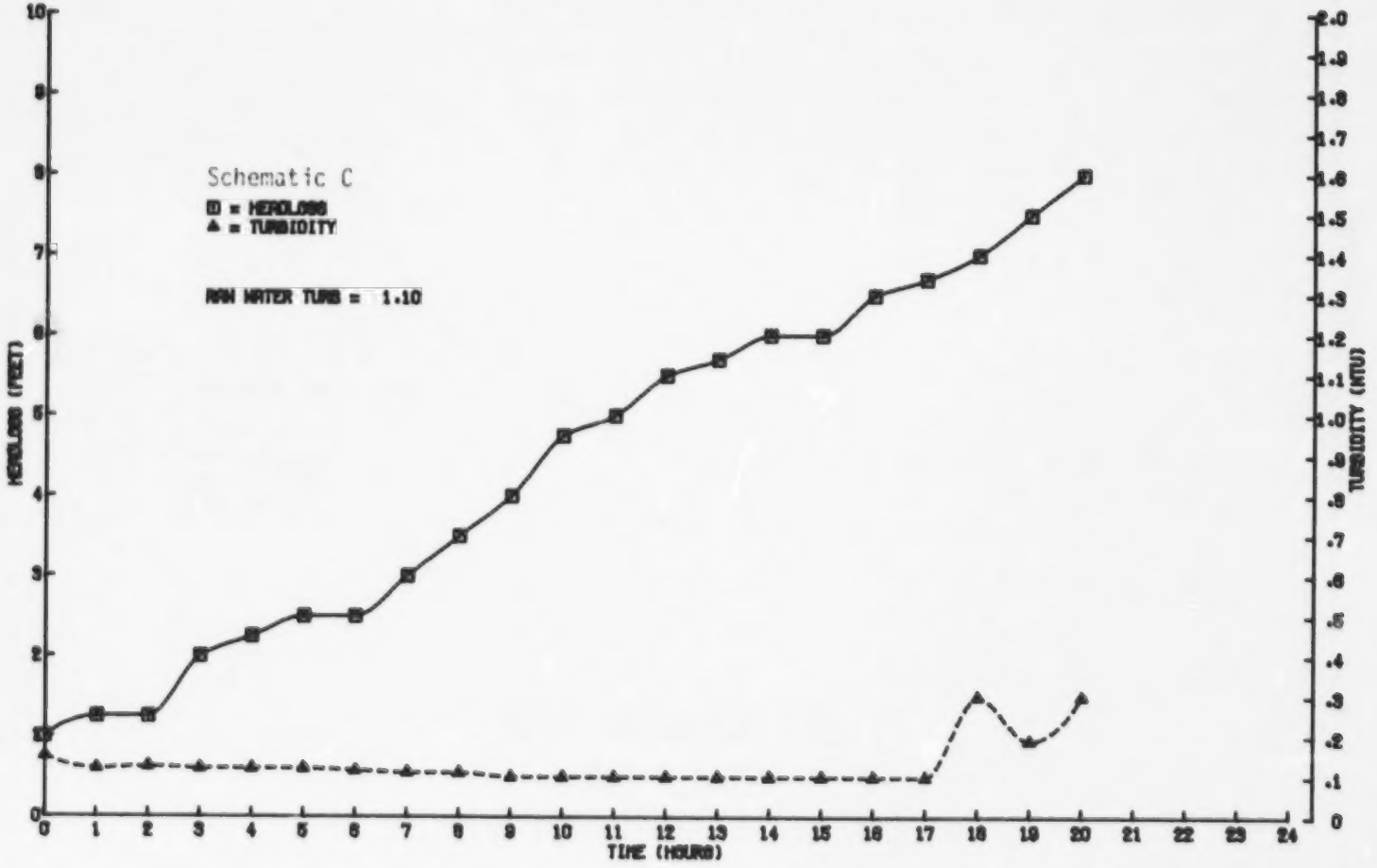

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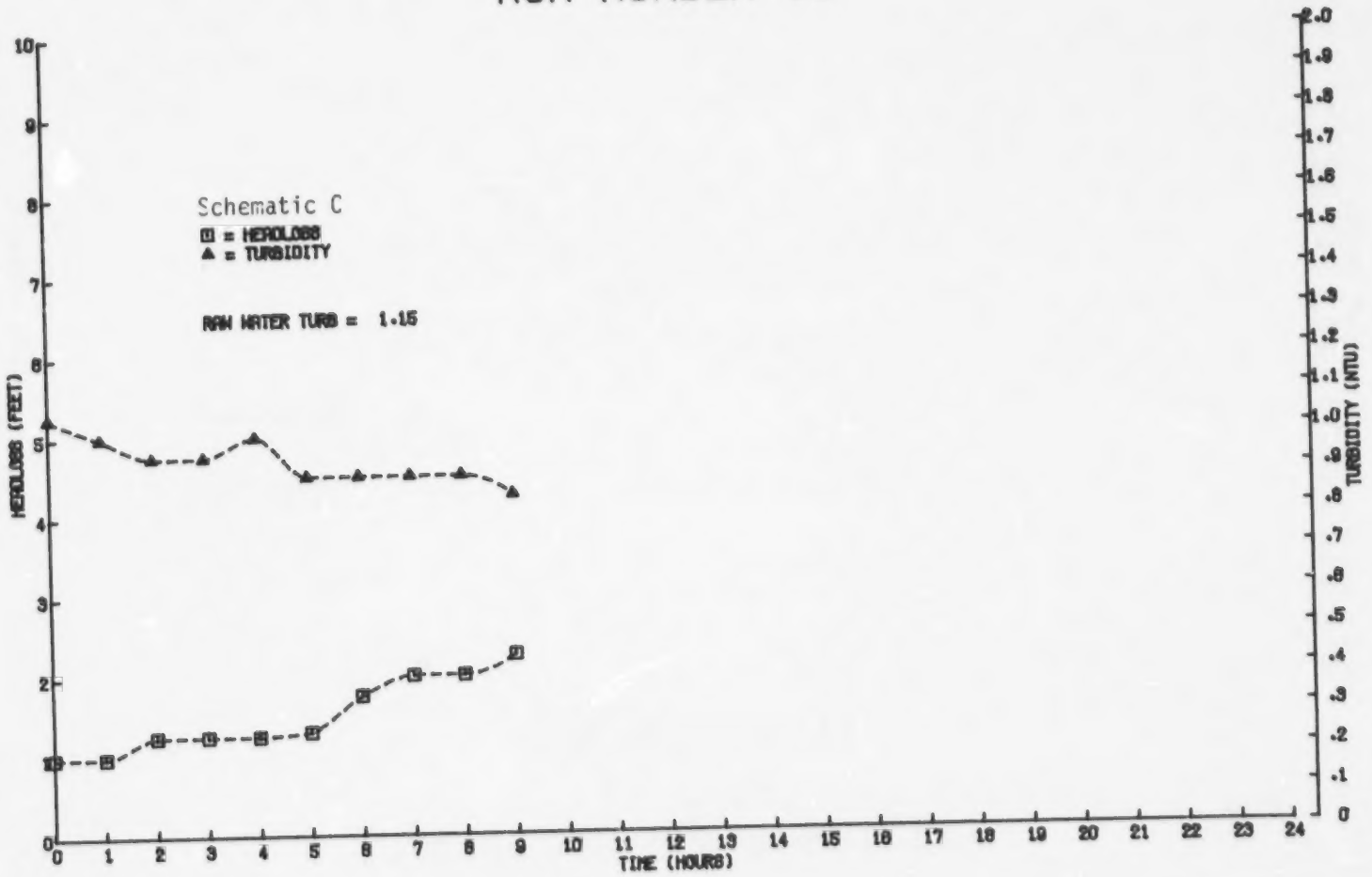

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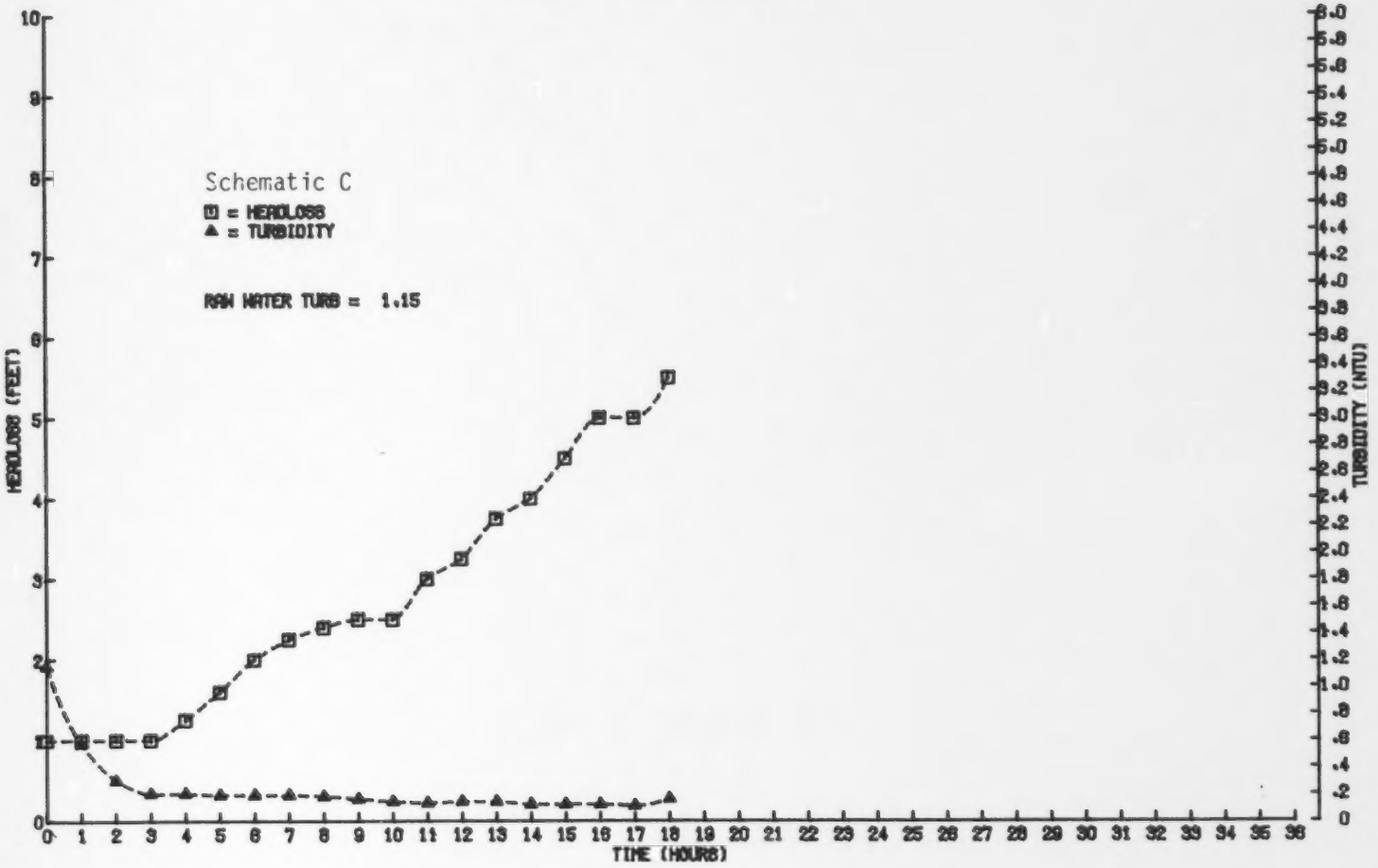

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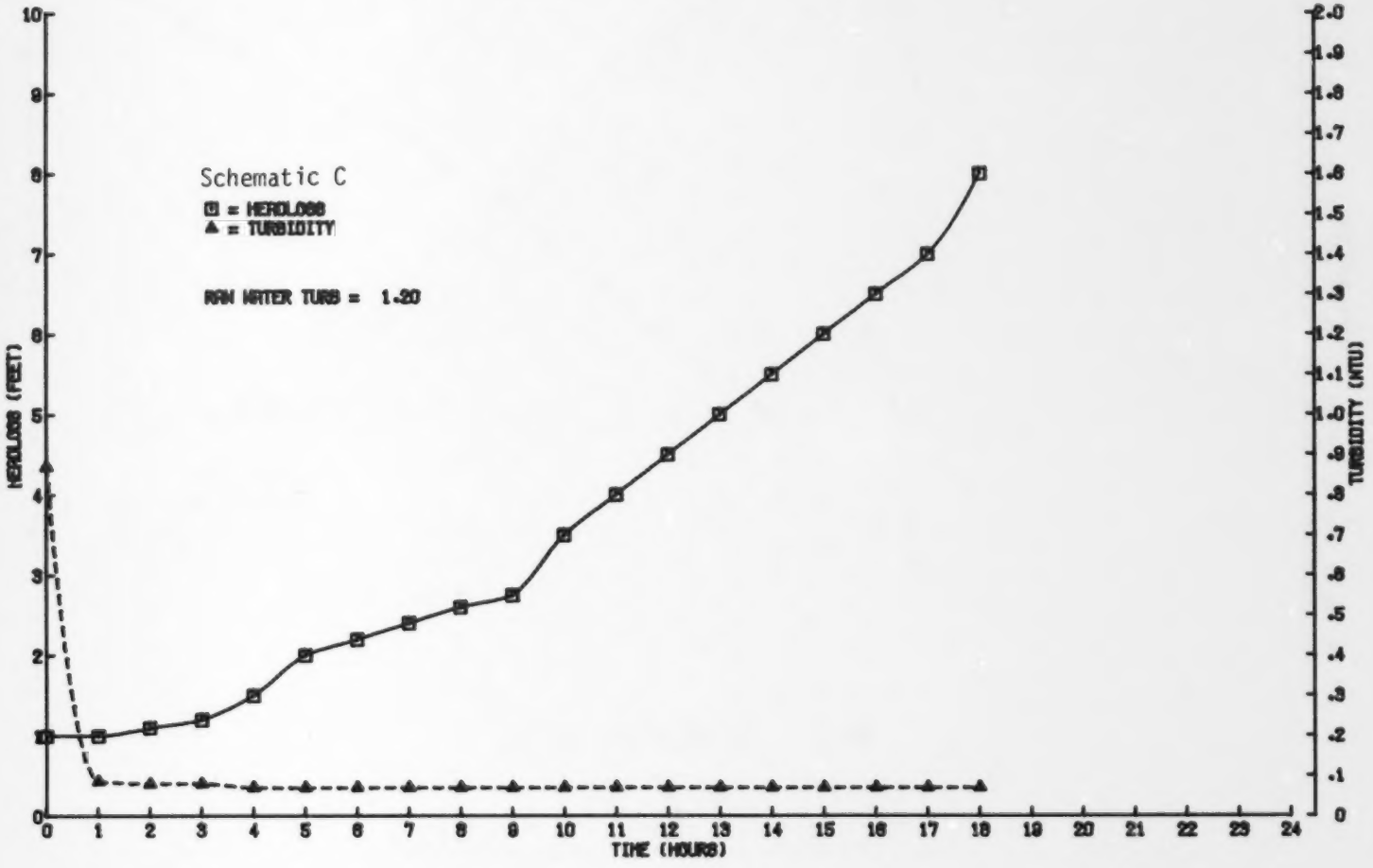

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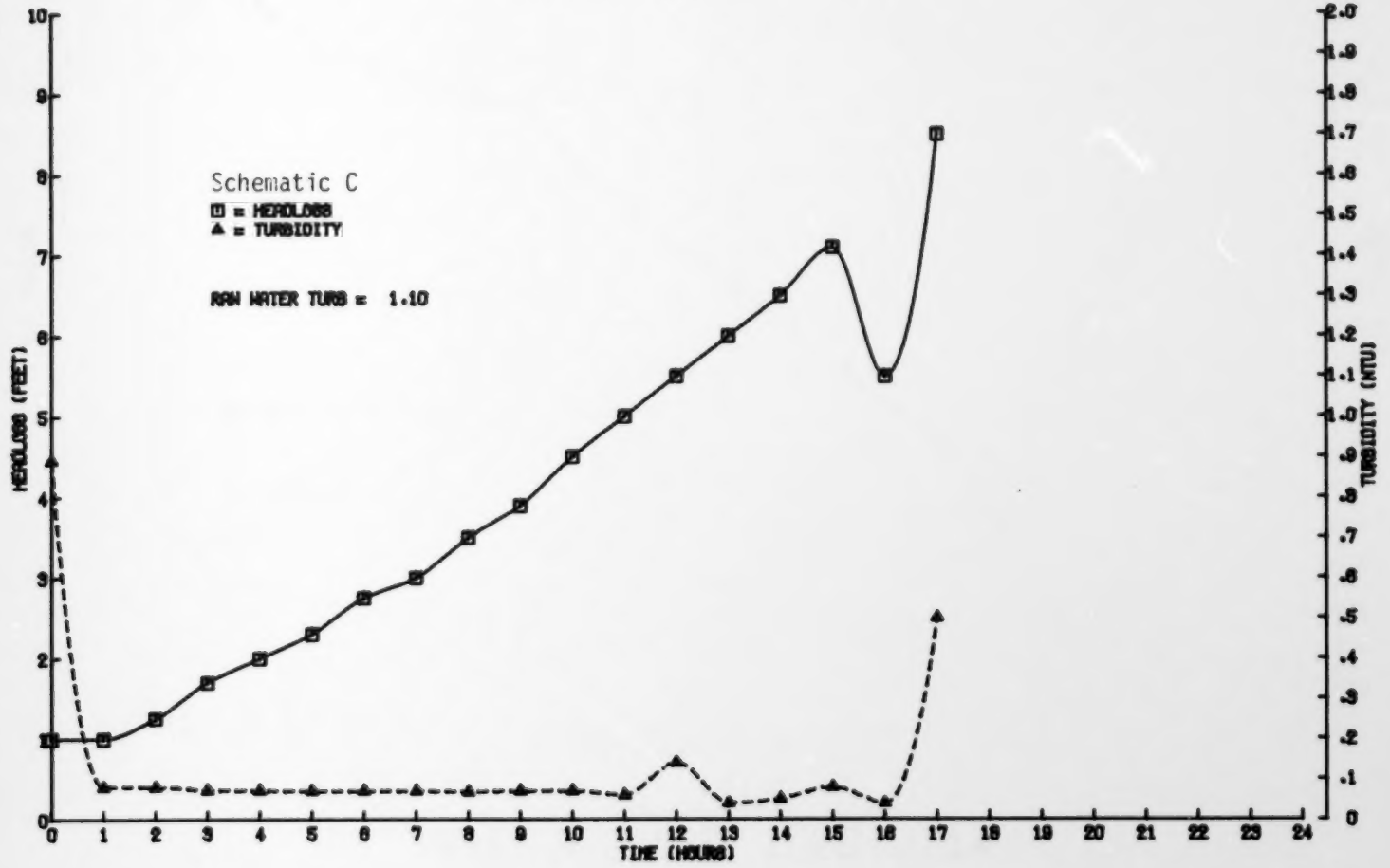

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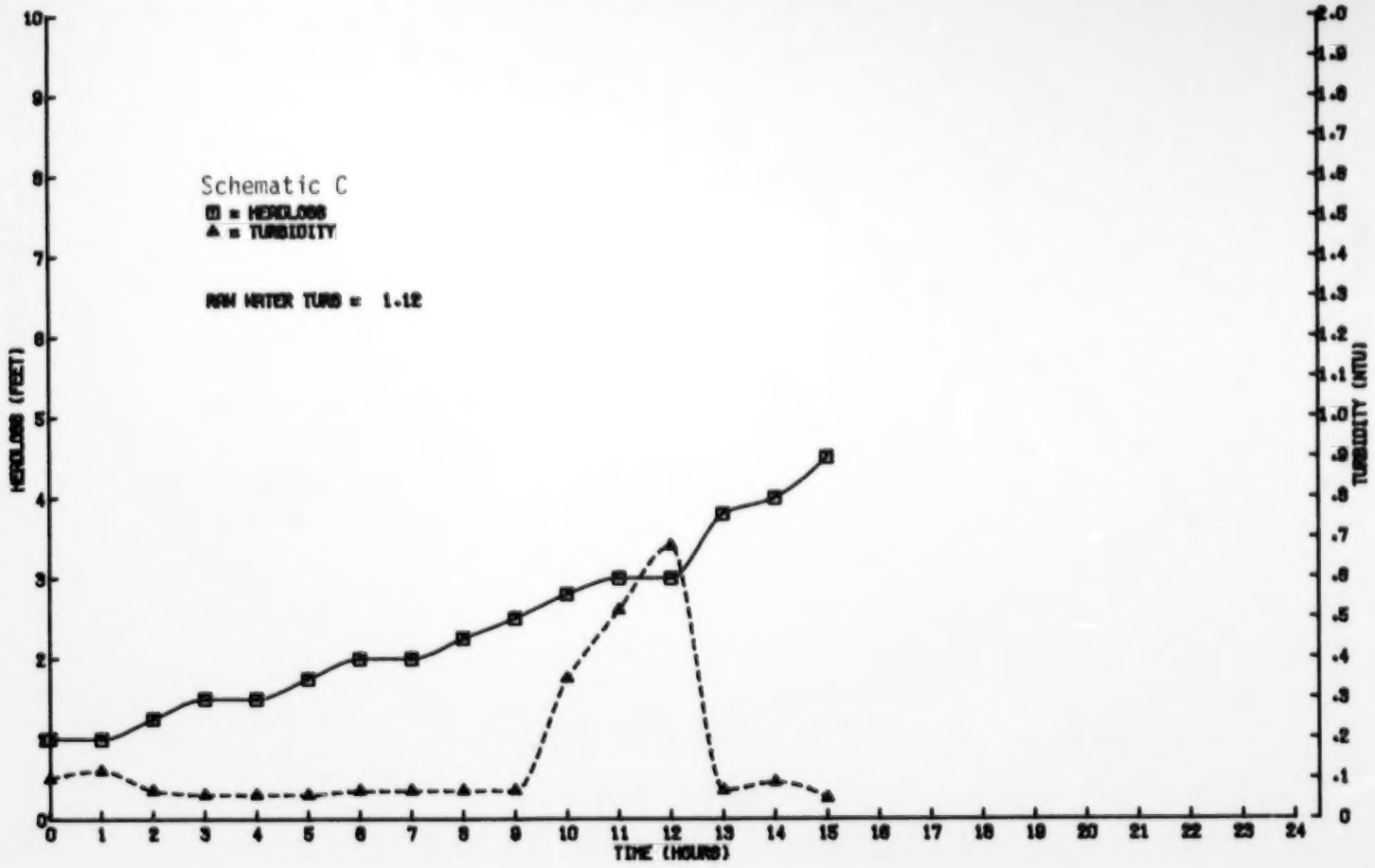

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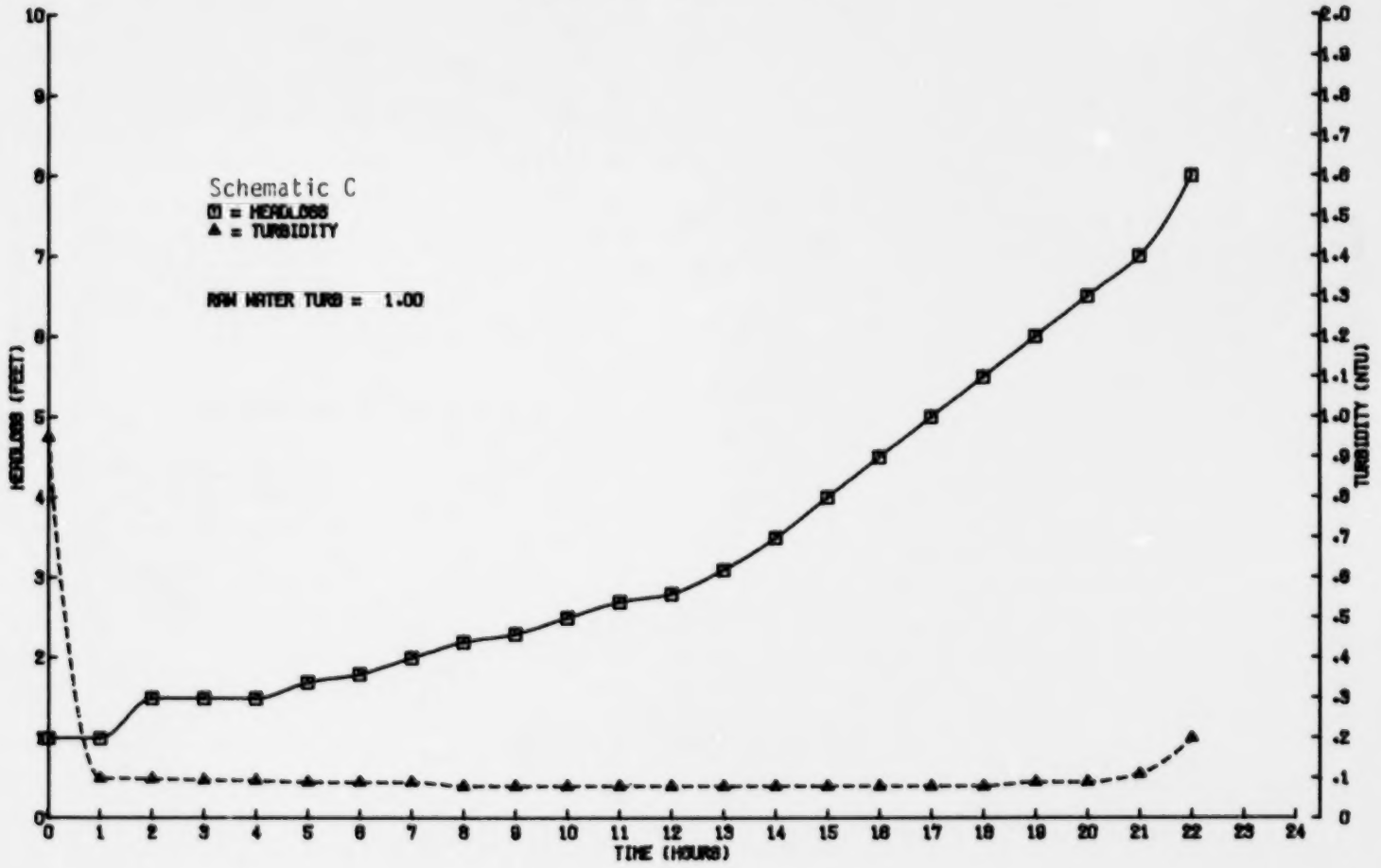

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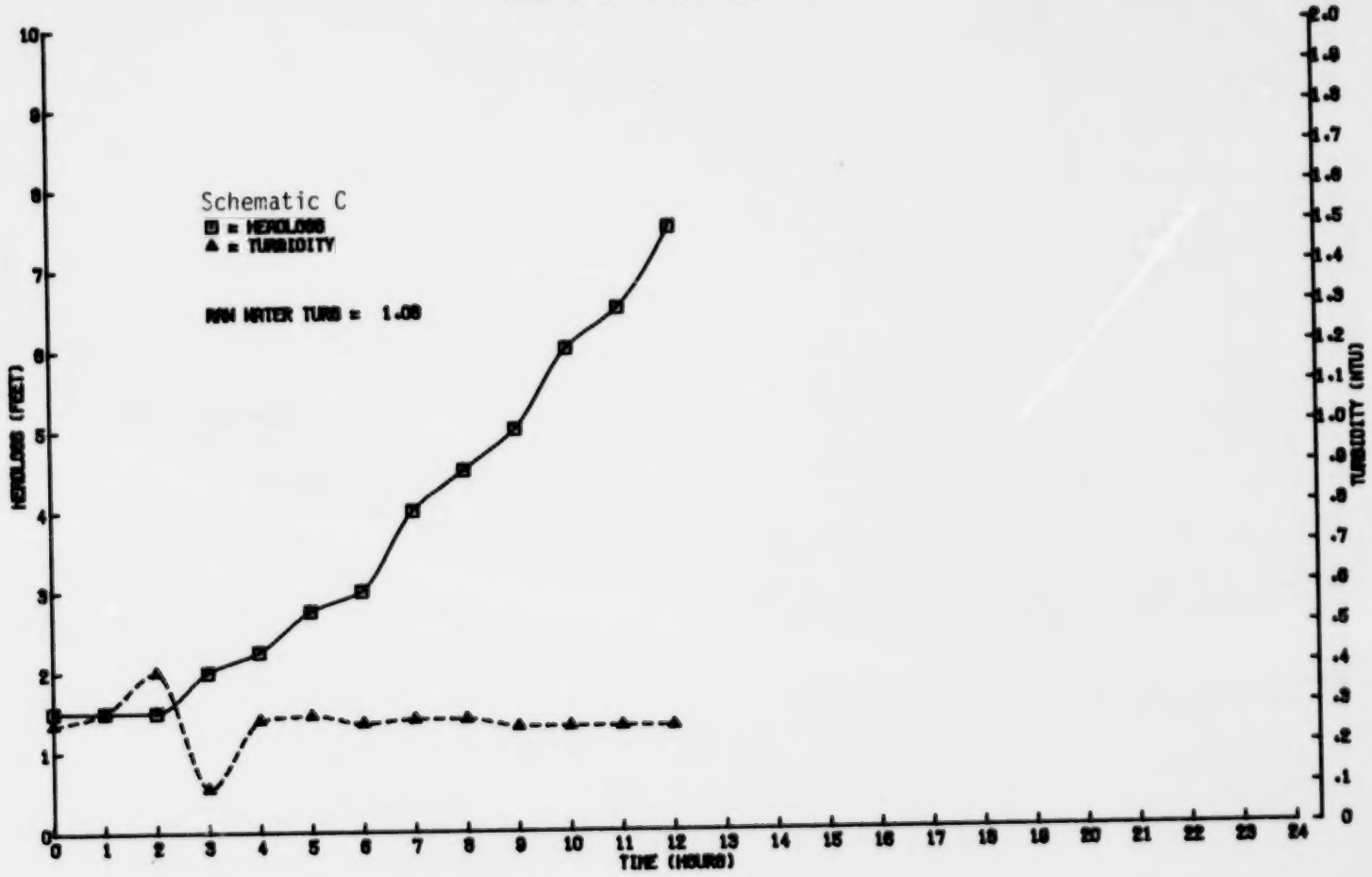

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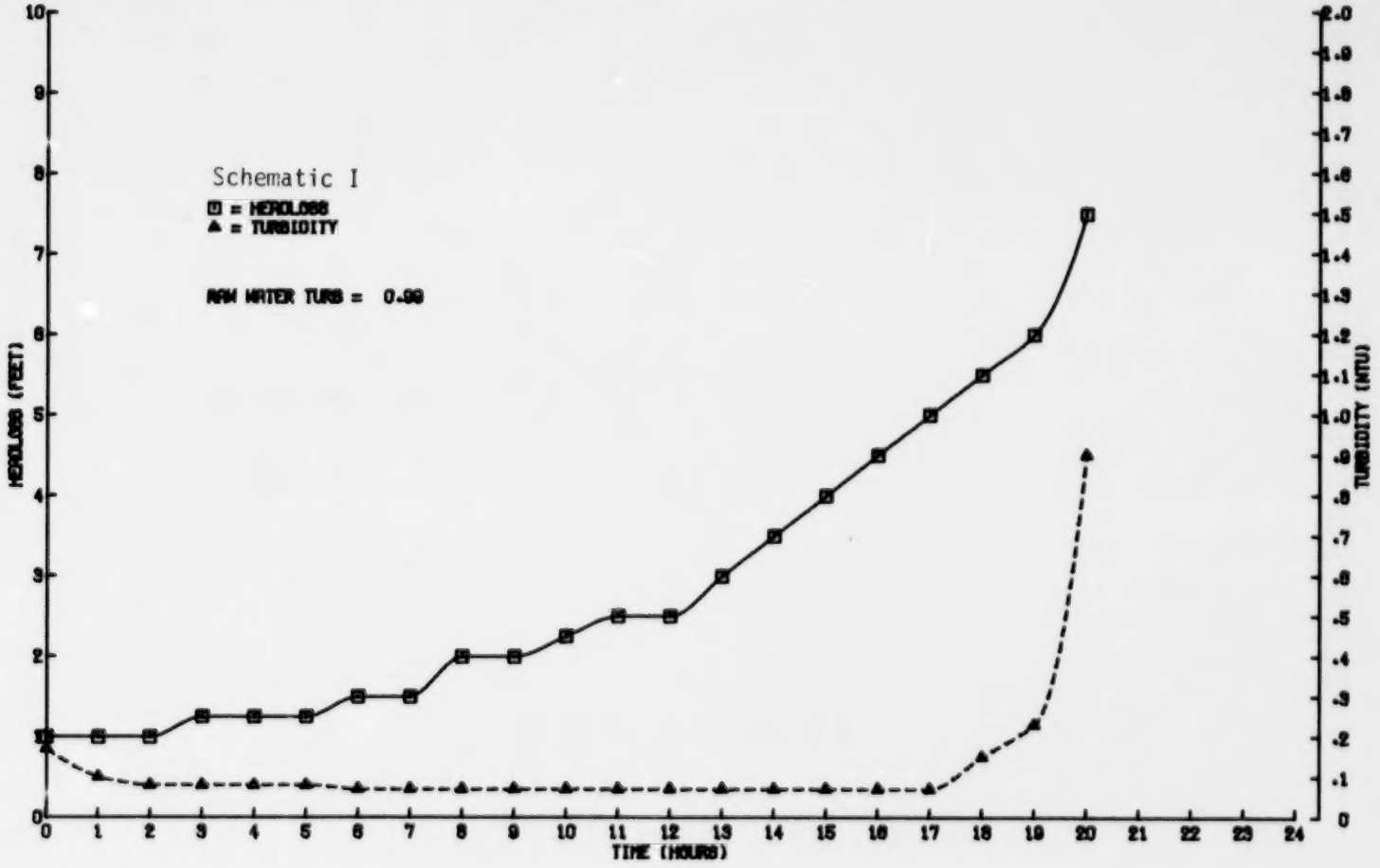

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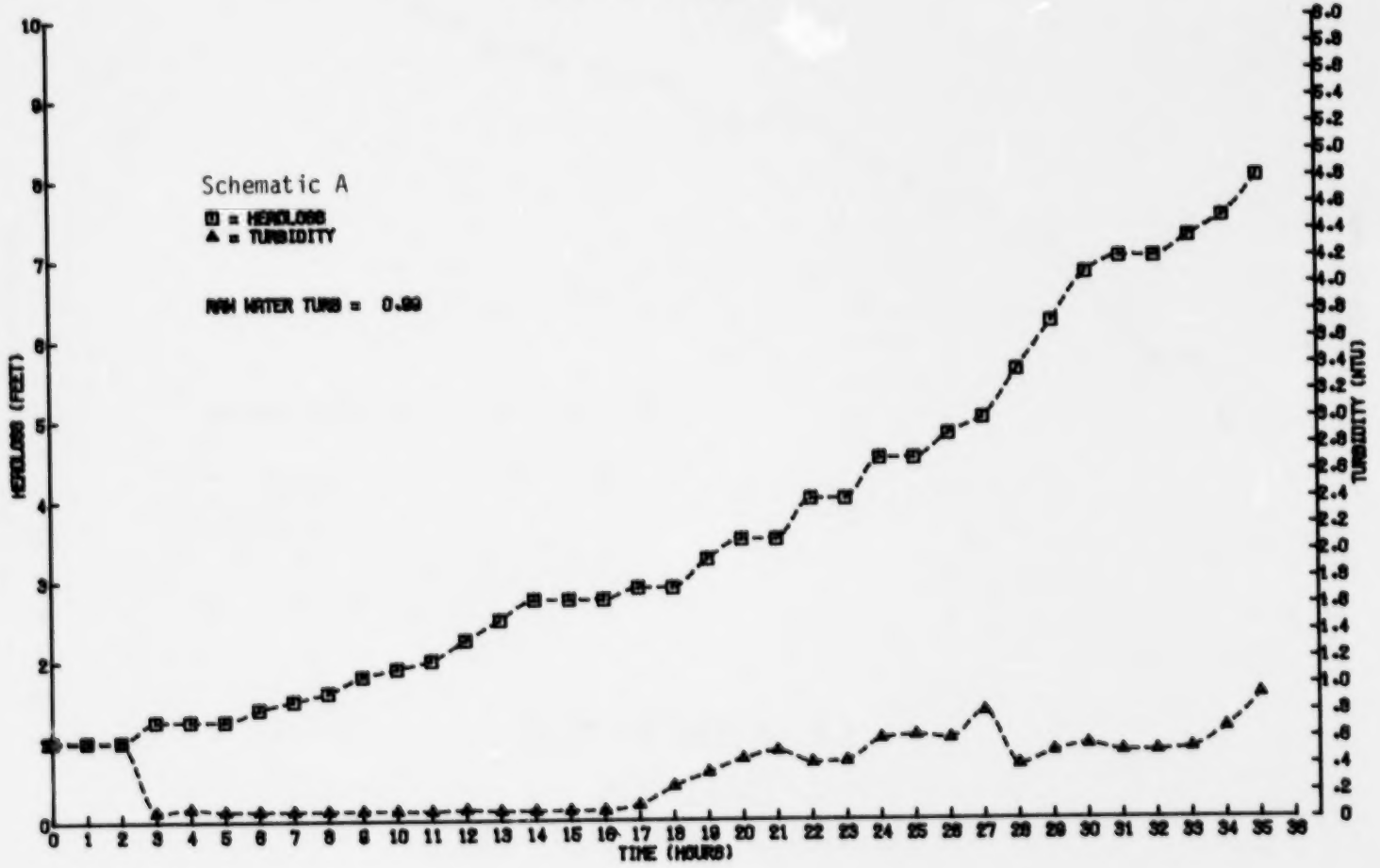

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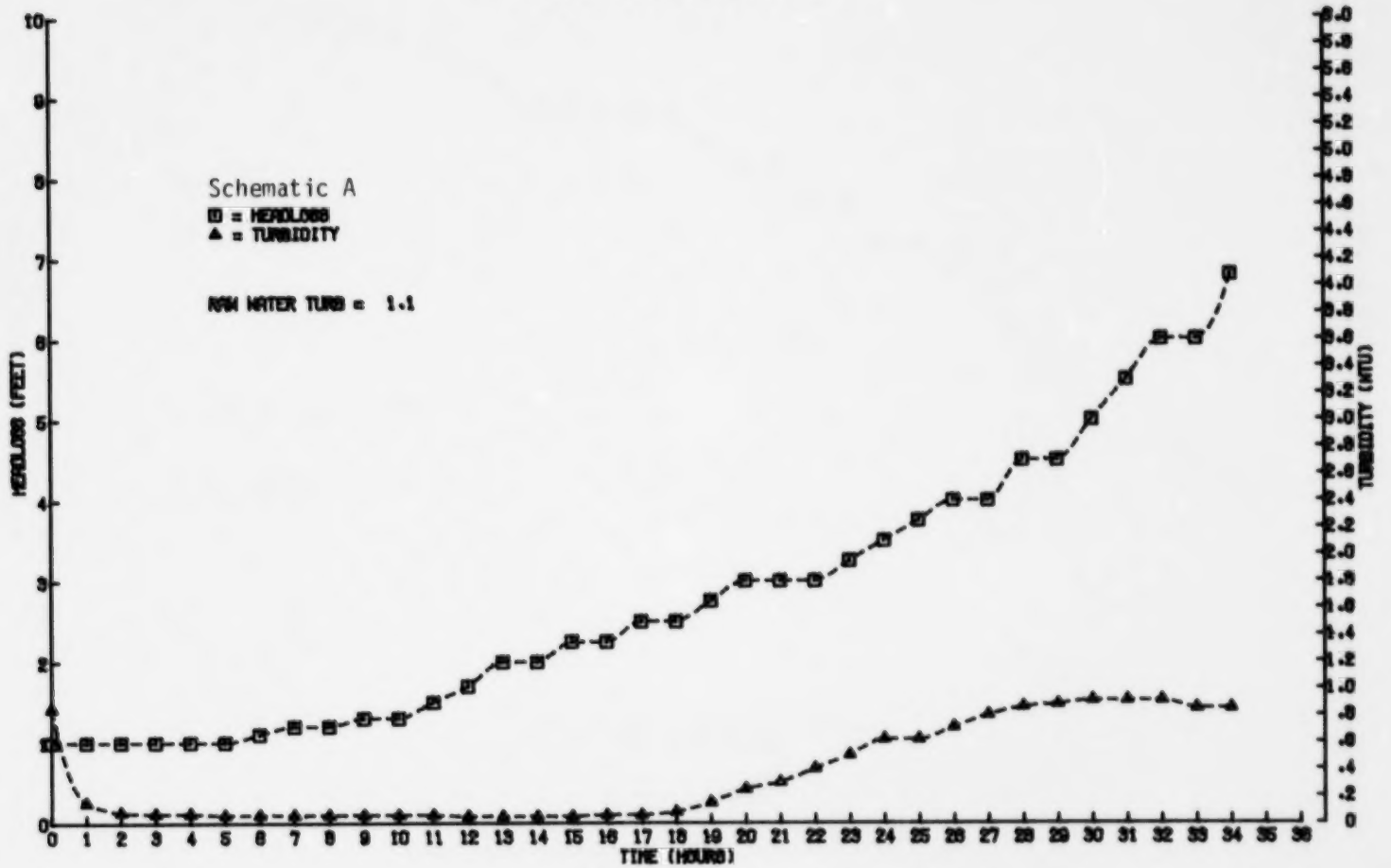

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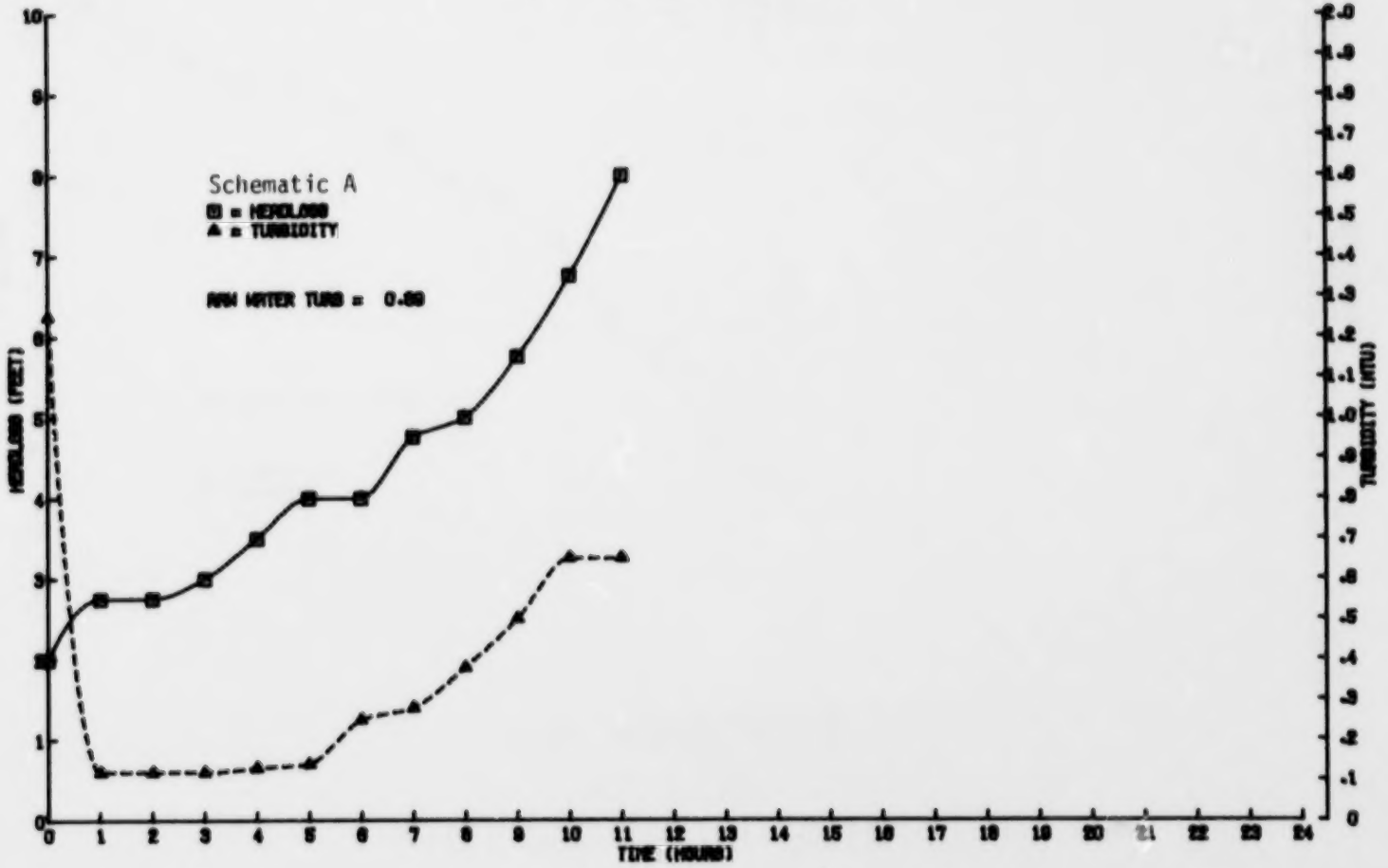

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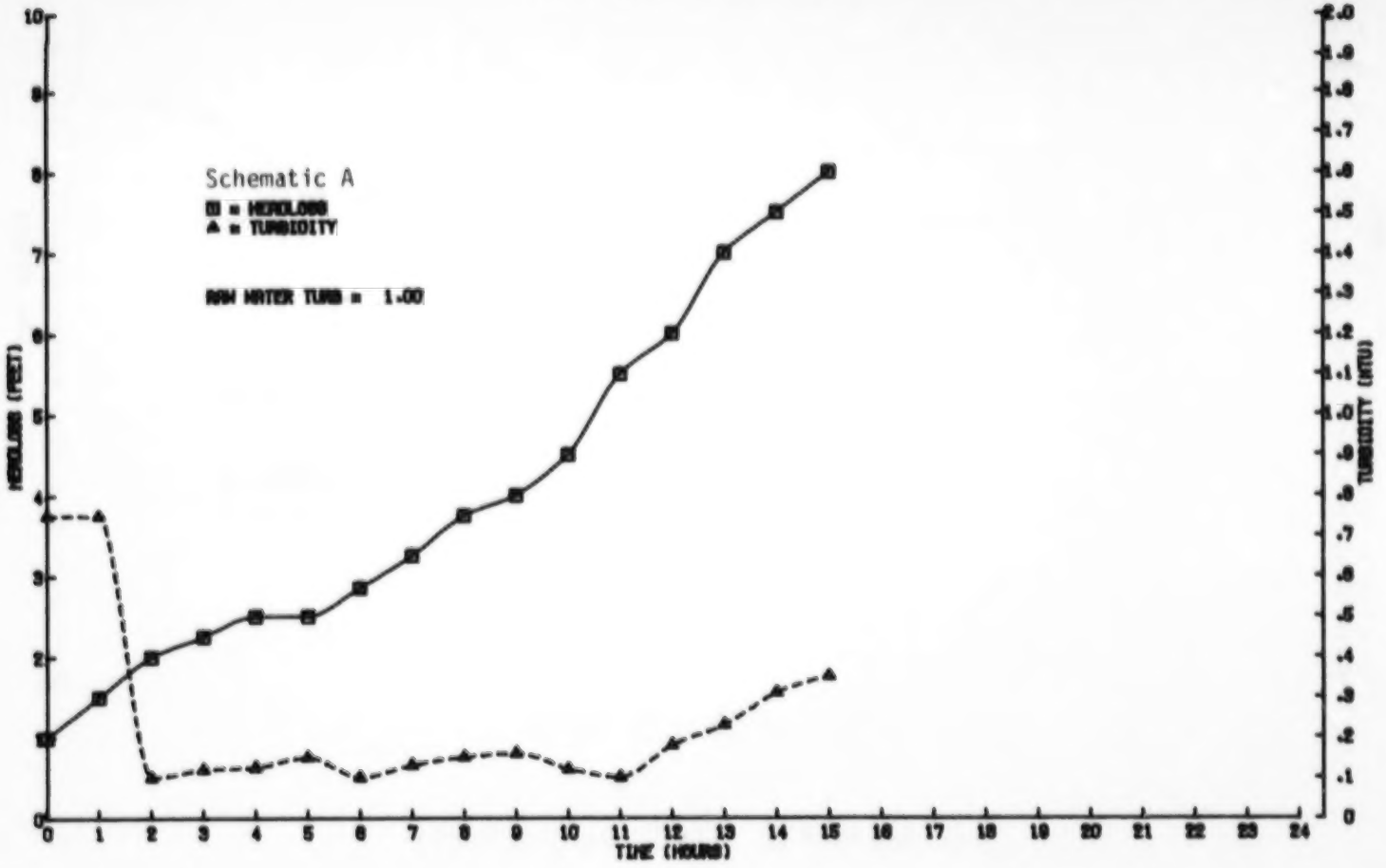

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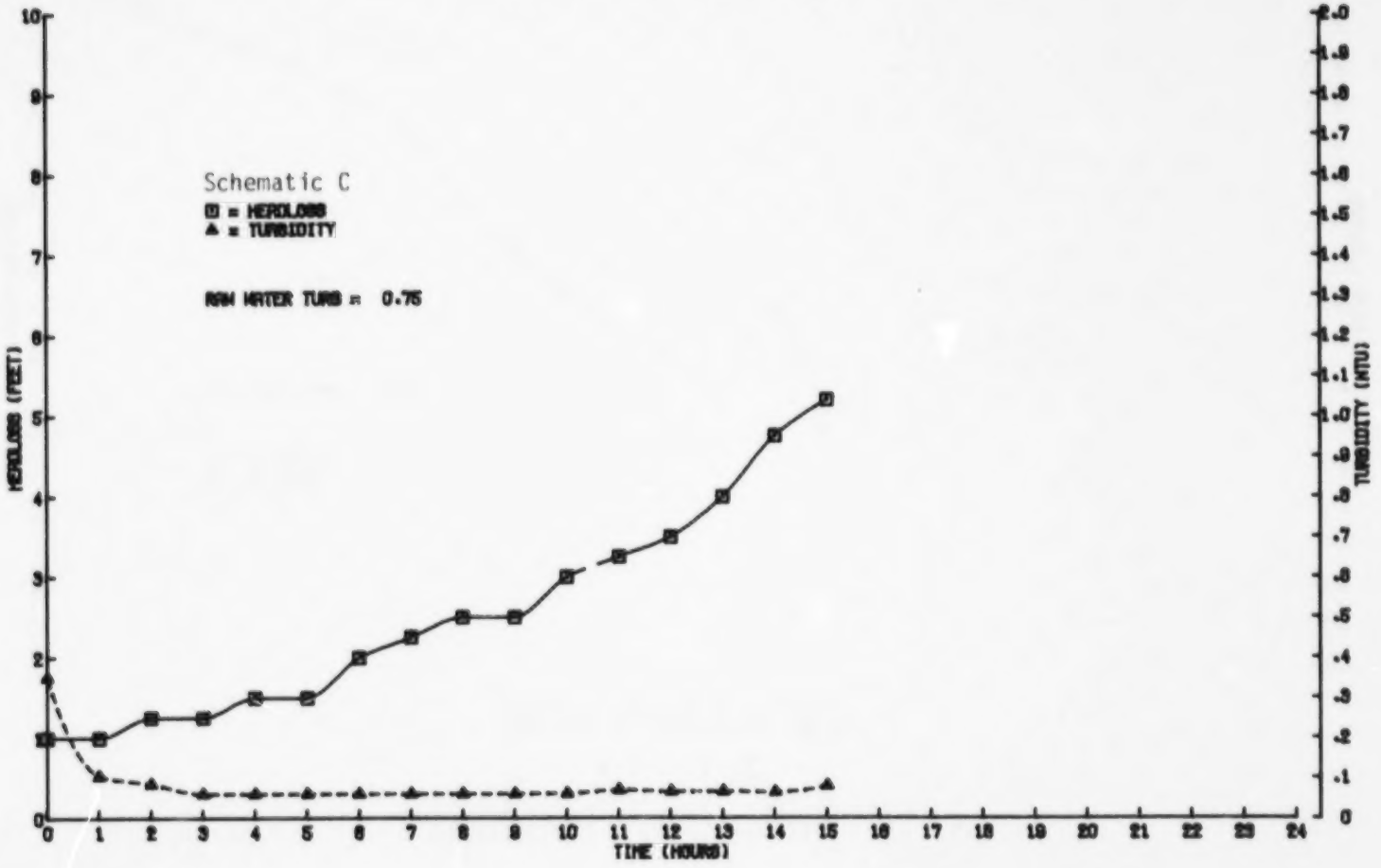

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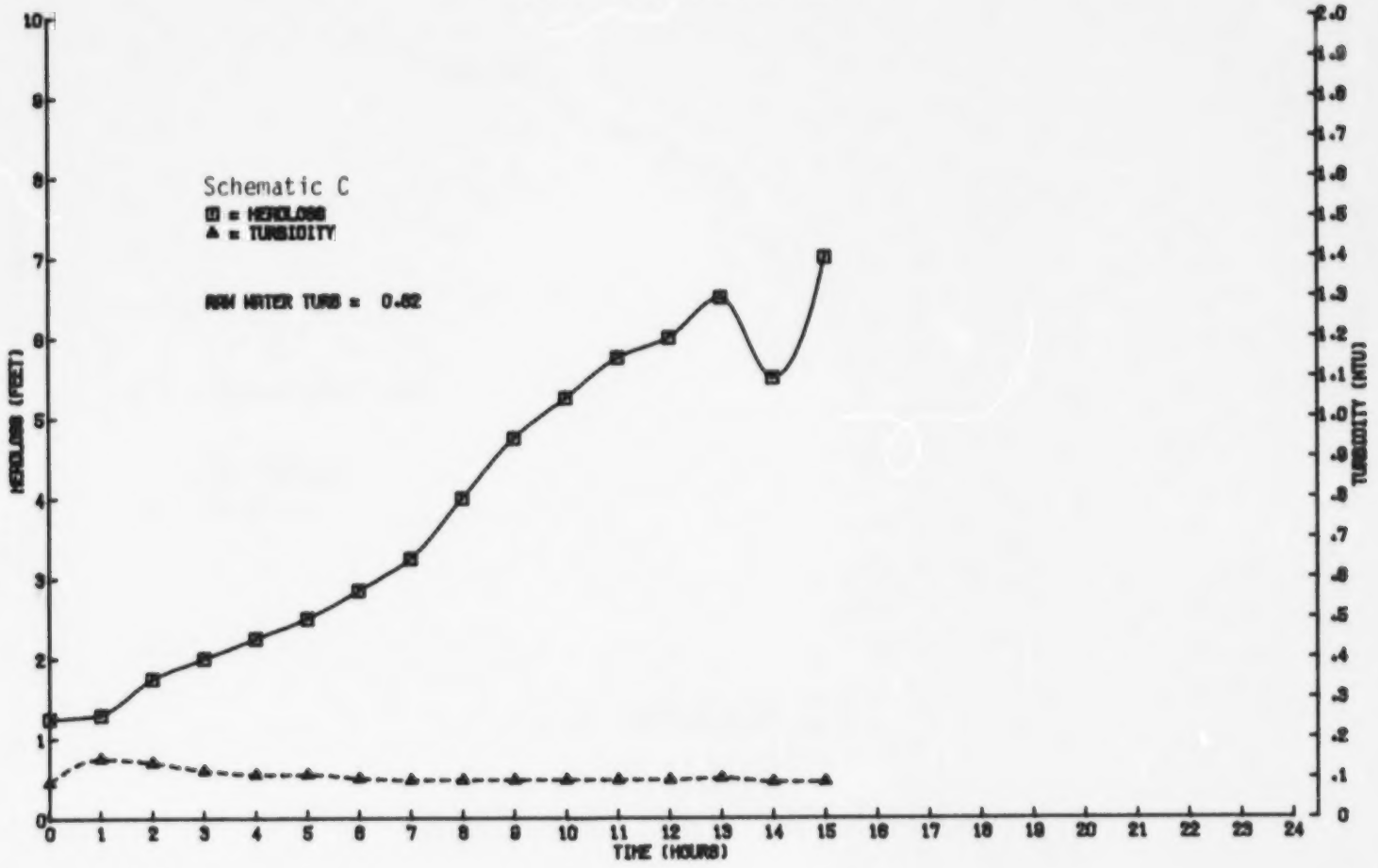

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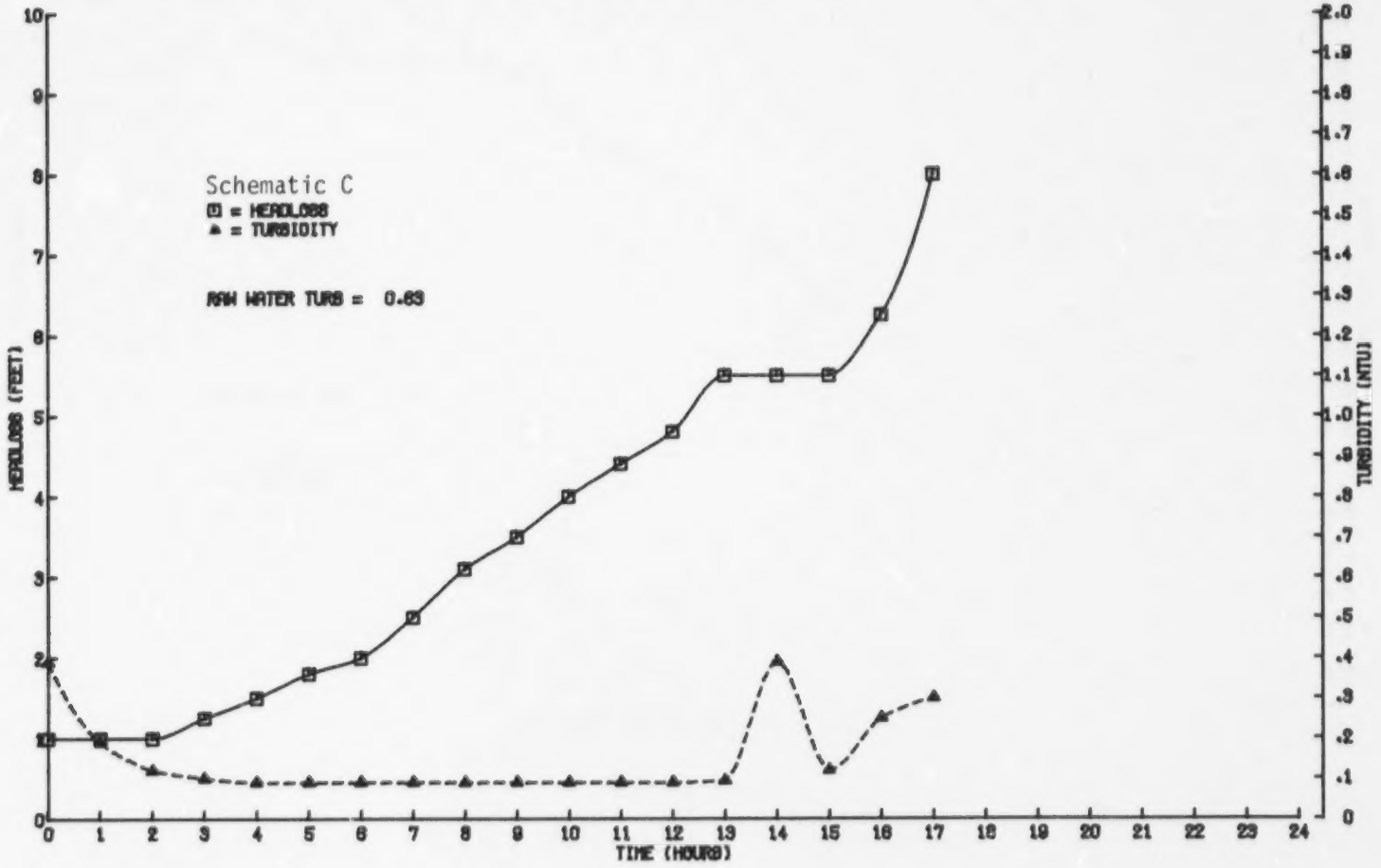

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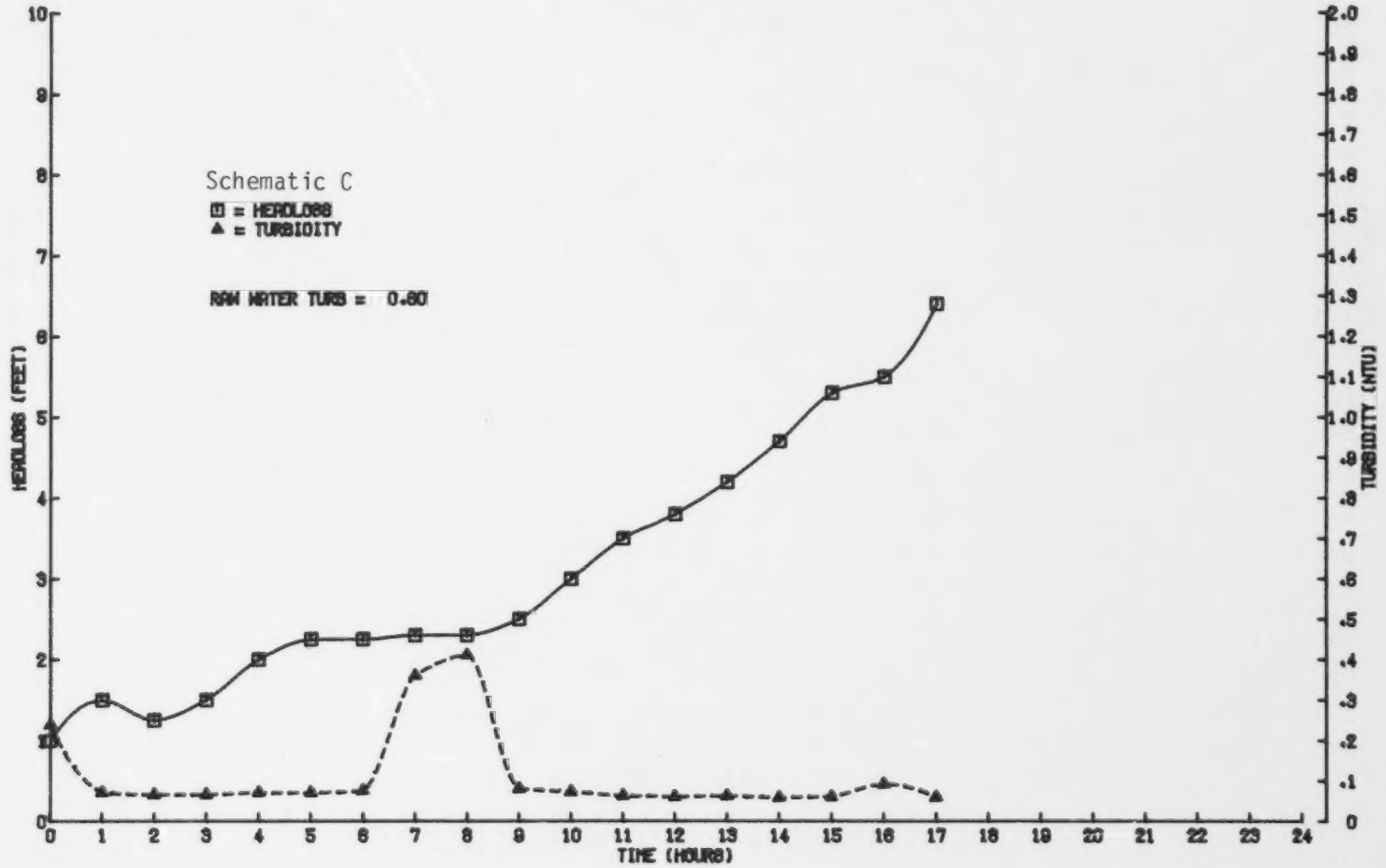

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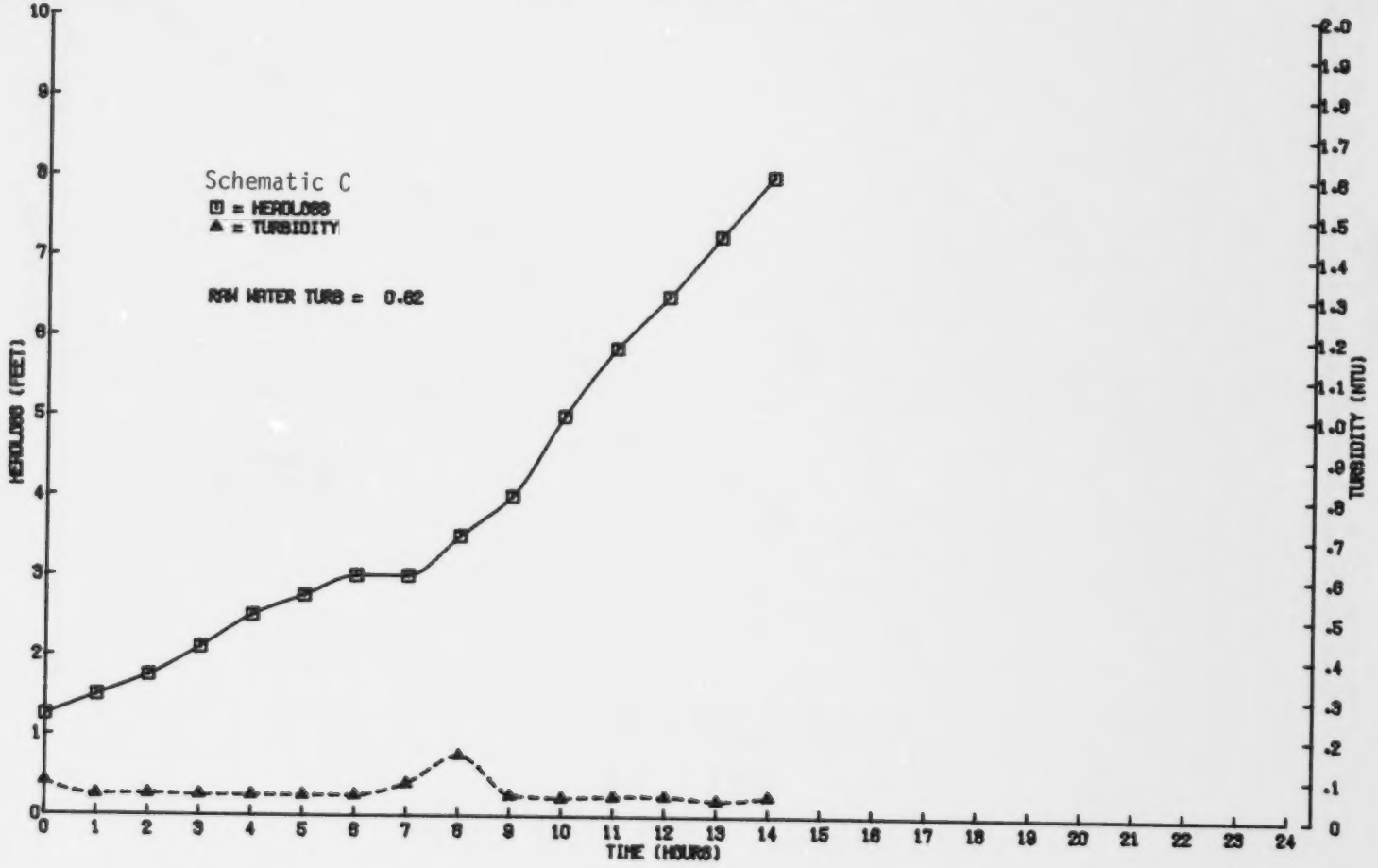

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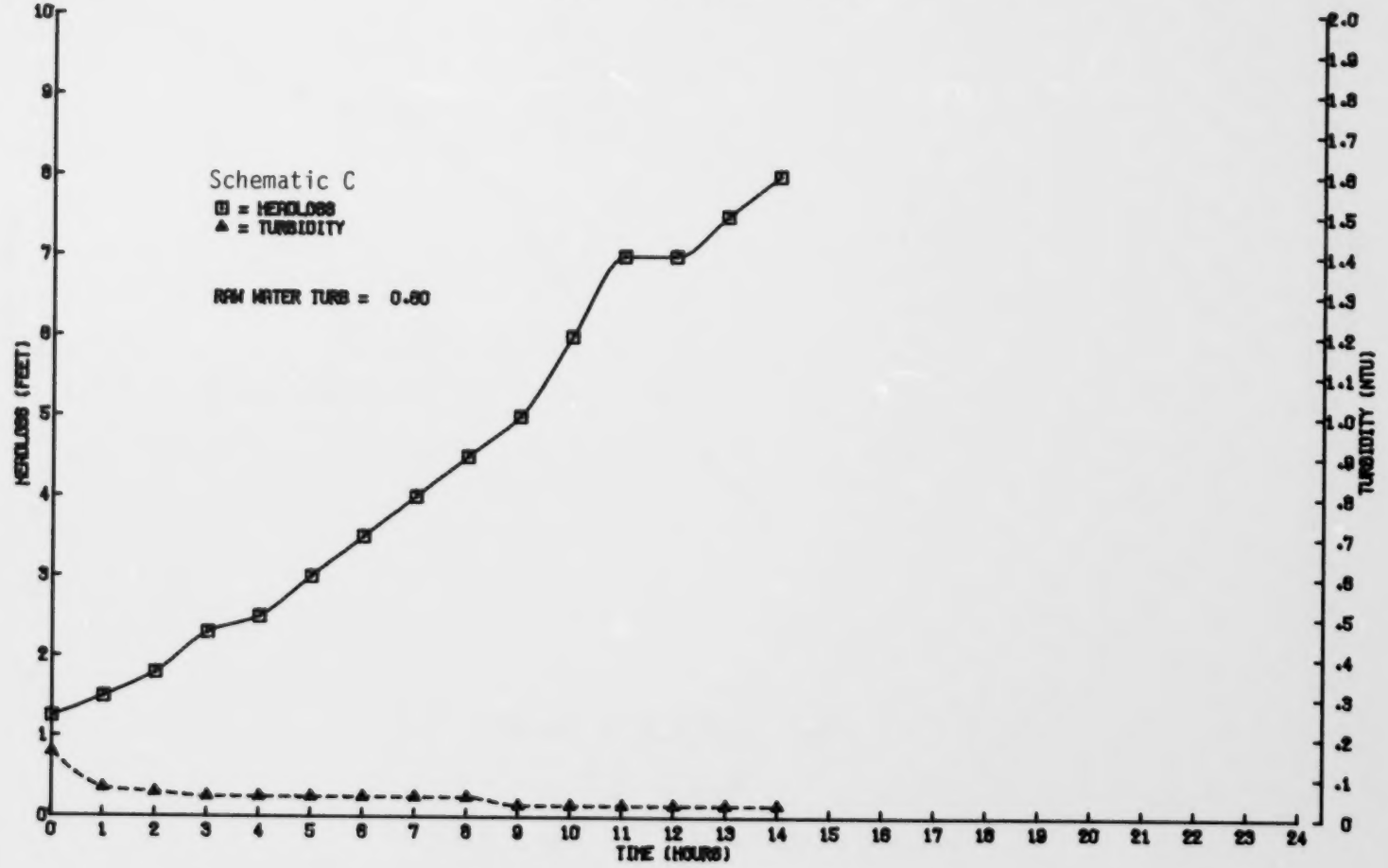

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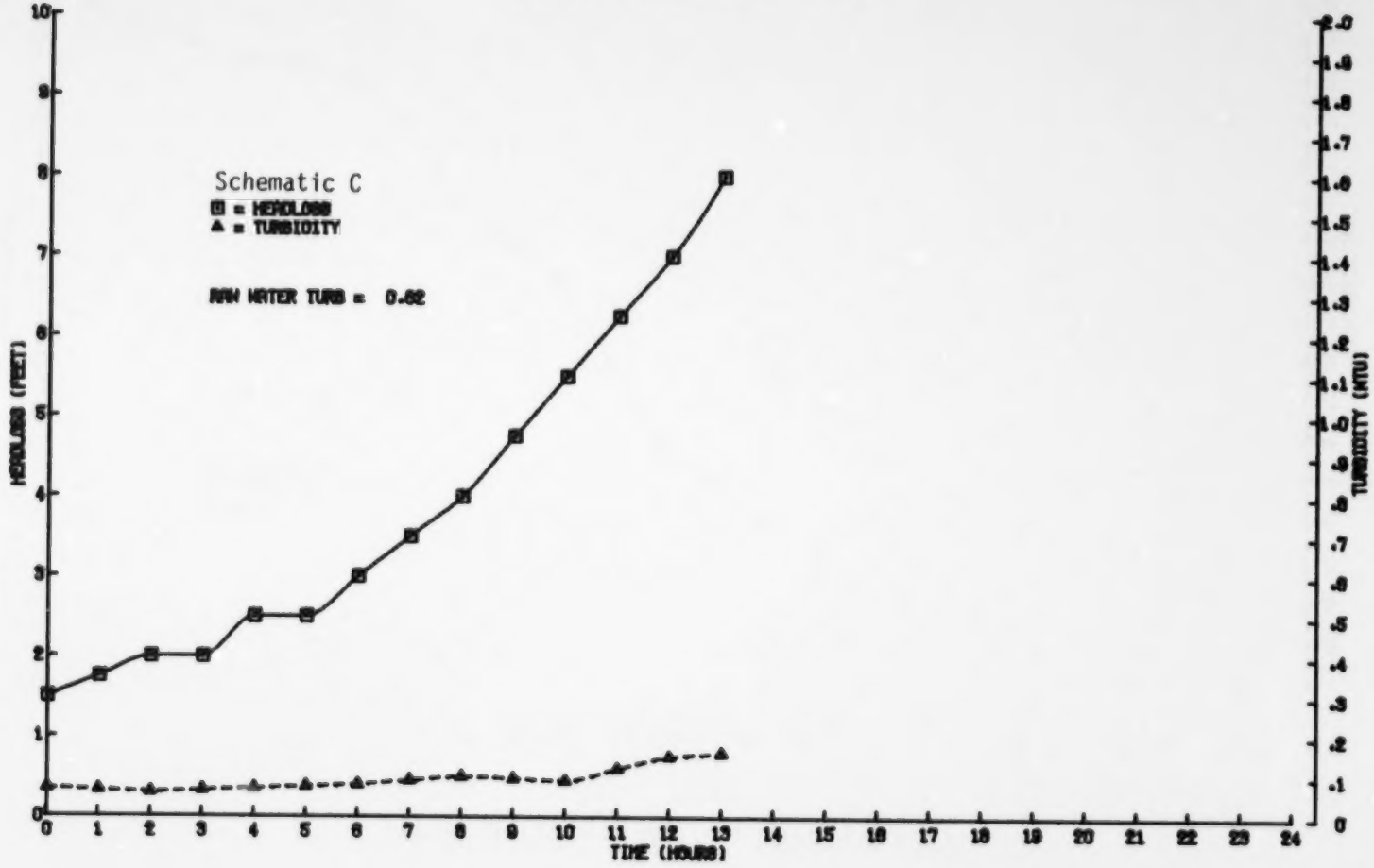

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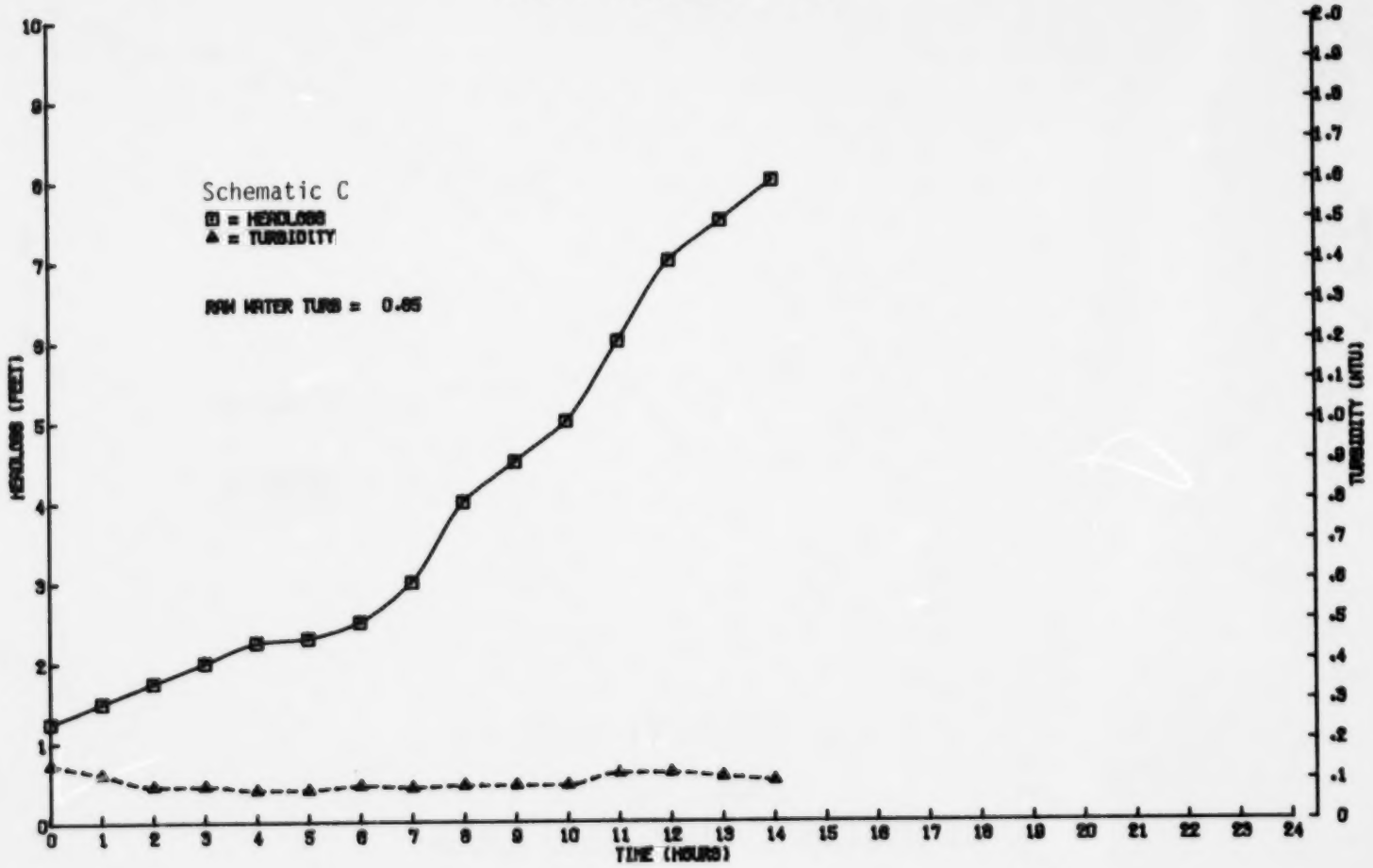
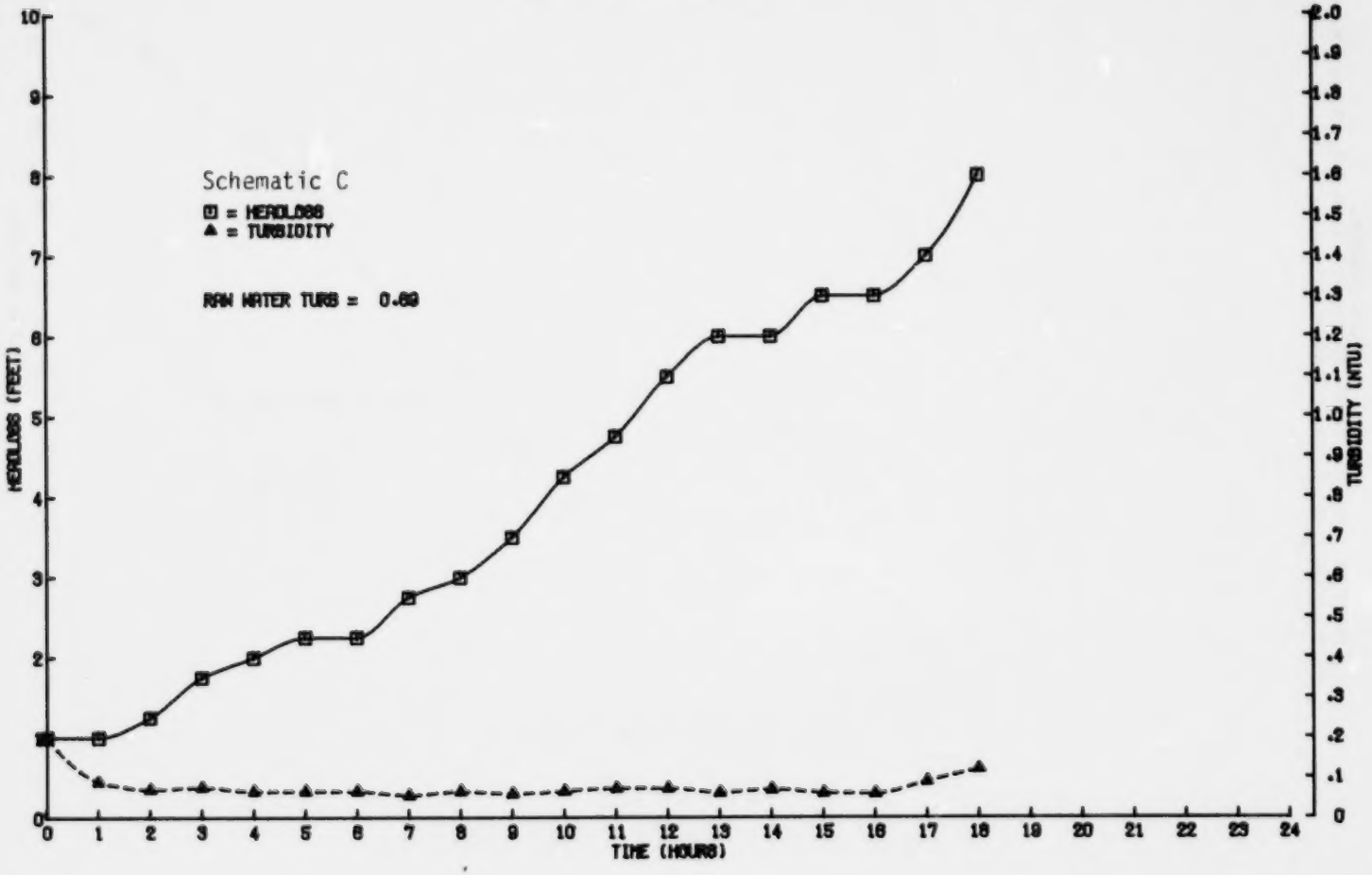
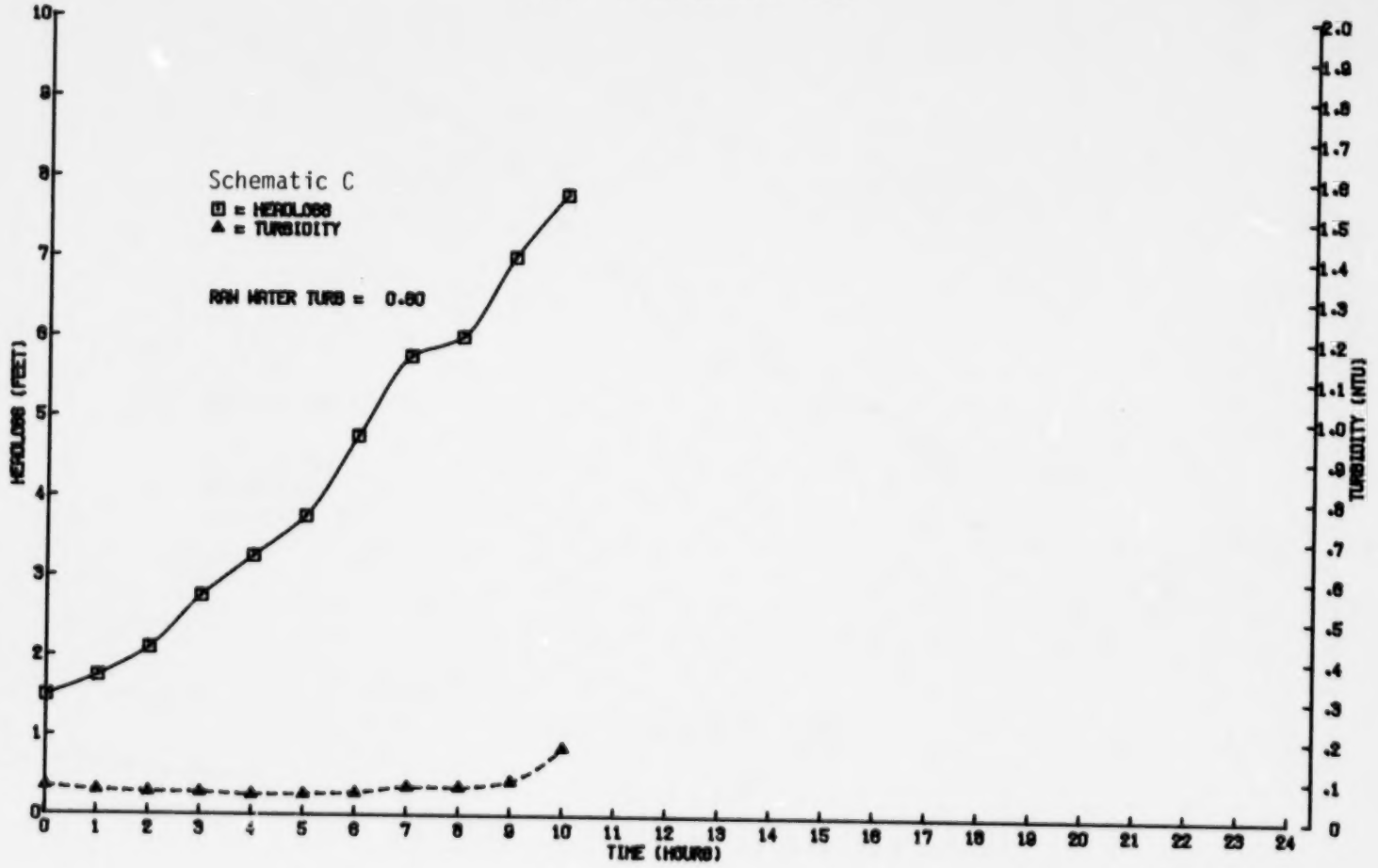


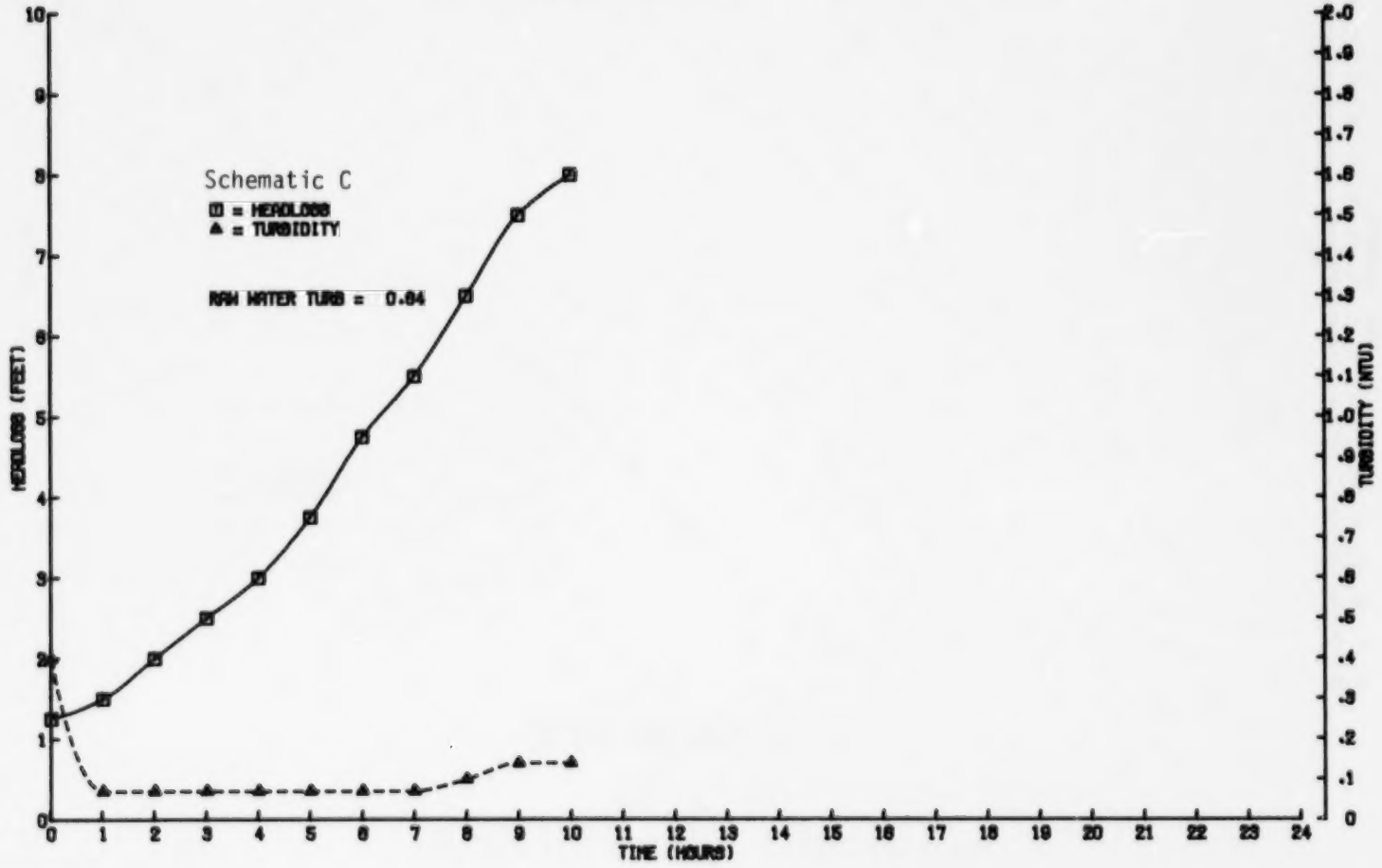
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 29



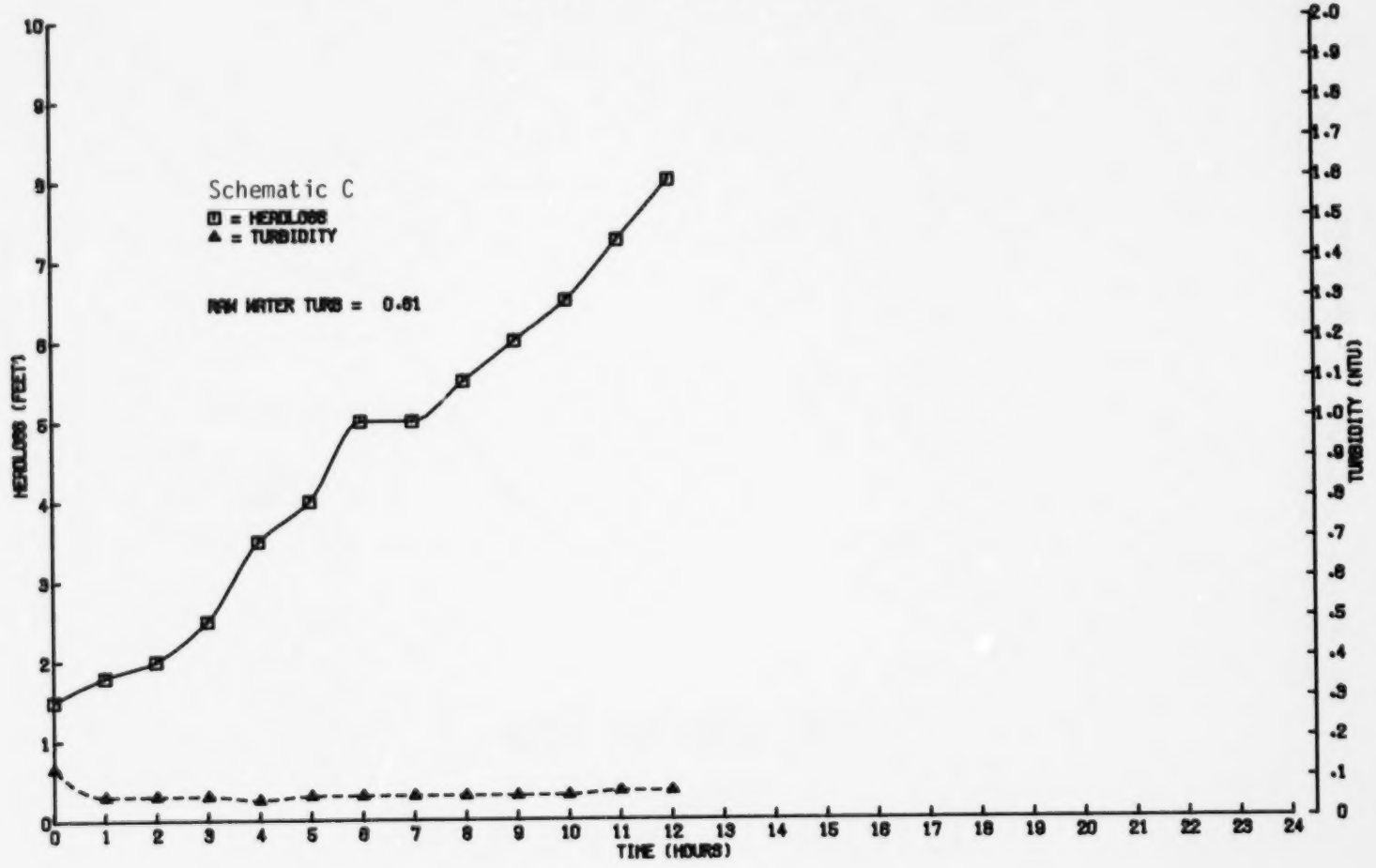
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 30



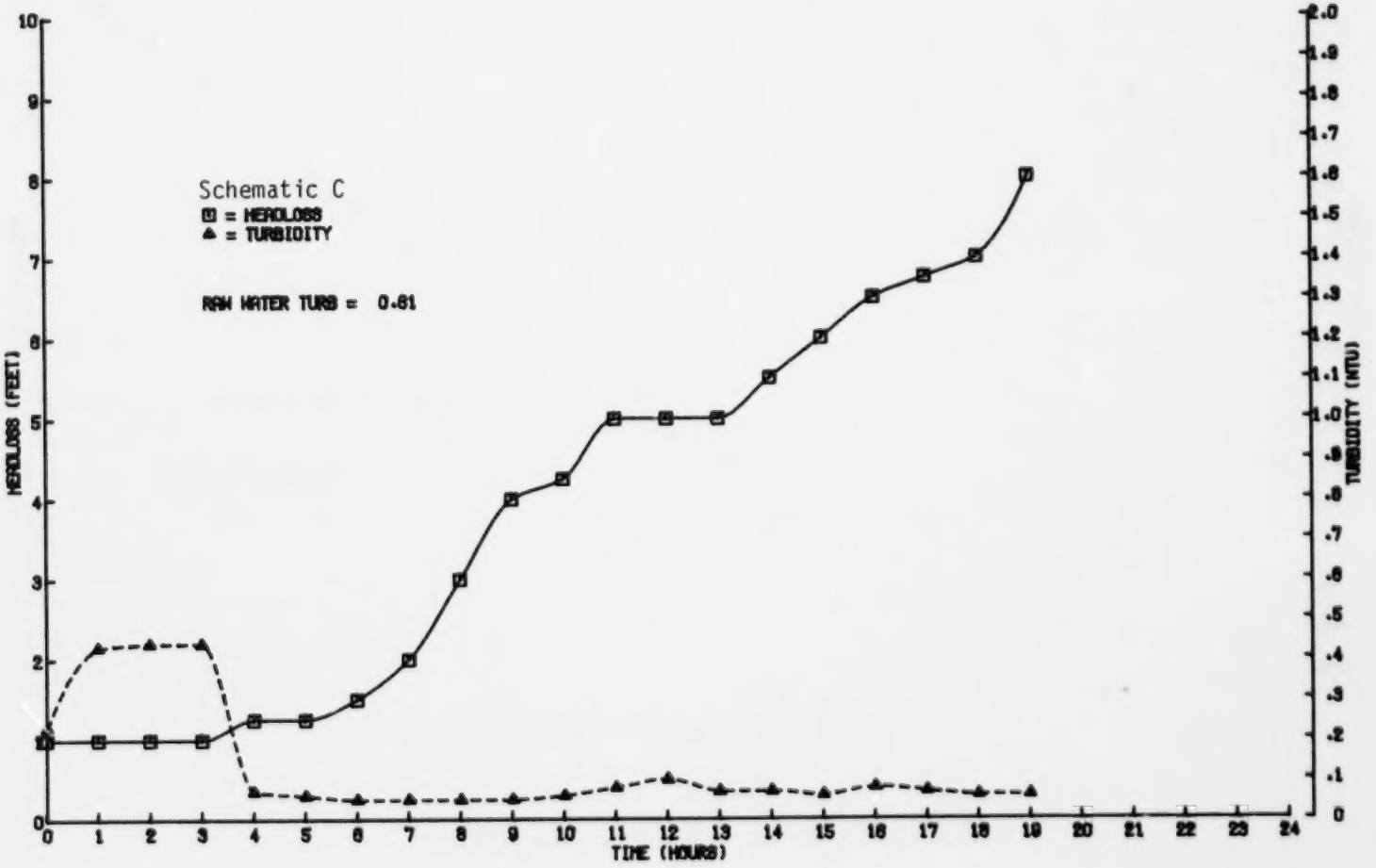
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 31



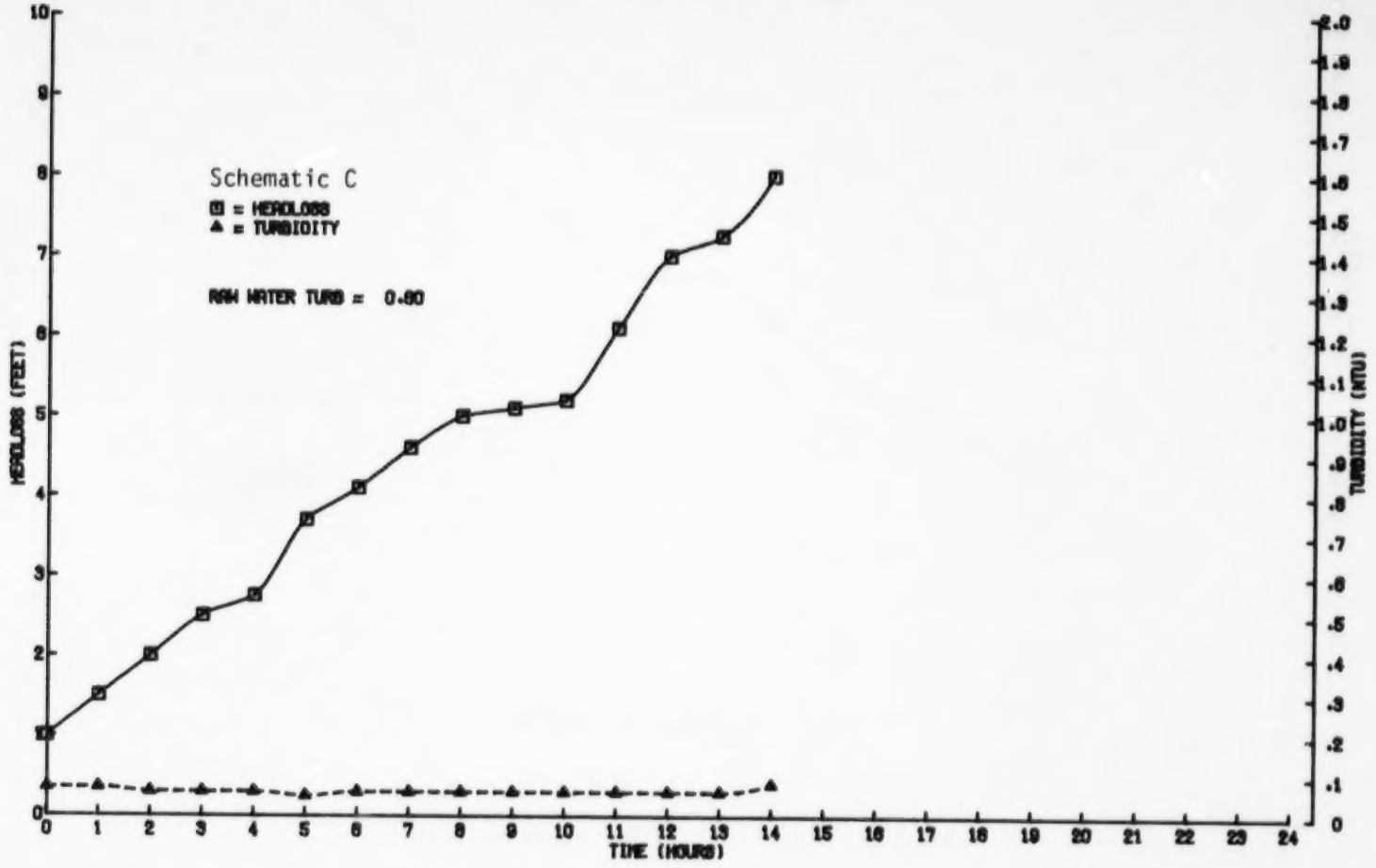
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 33



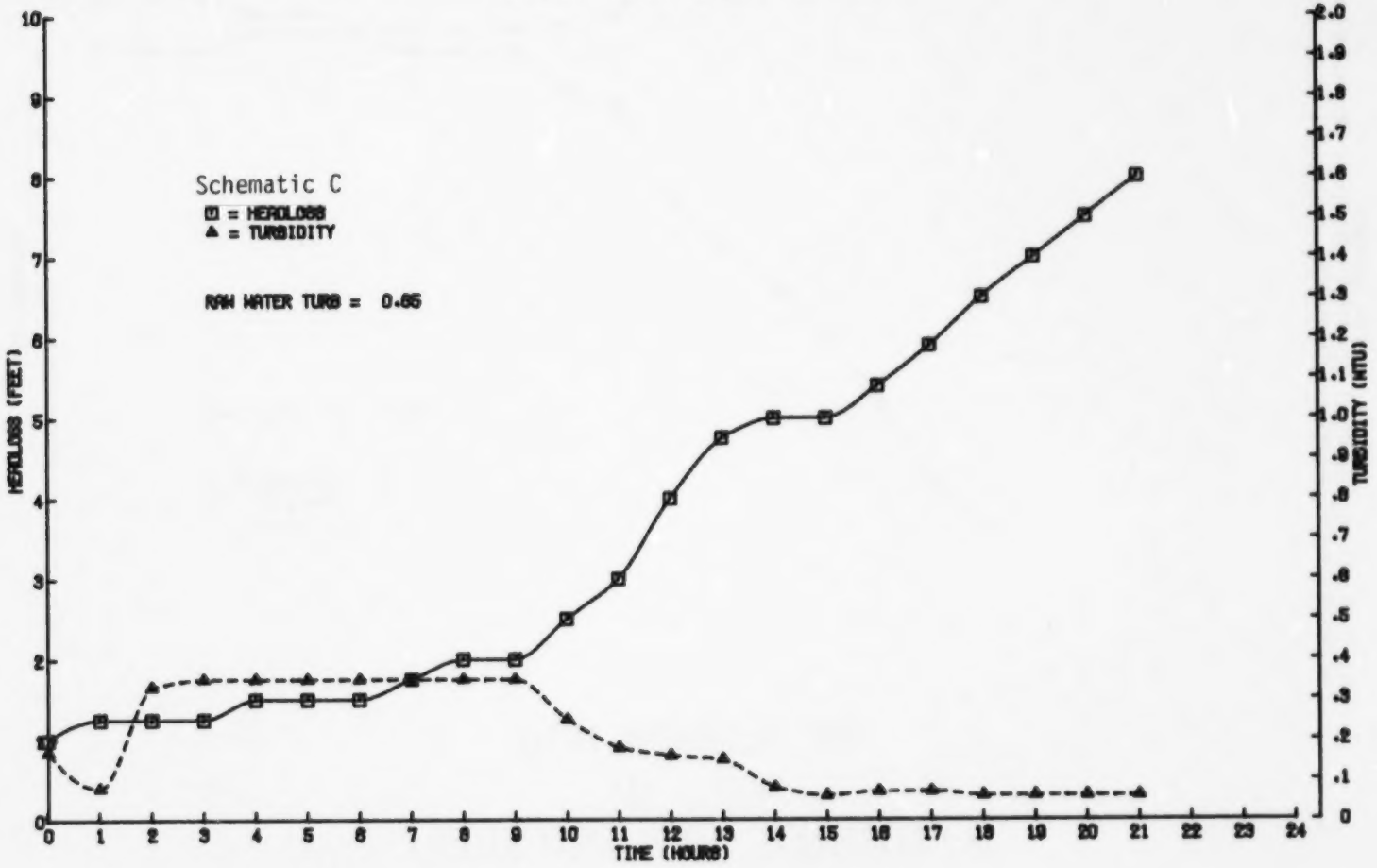
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 34



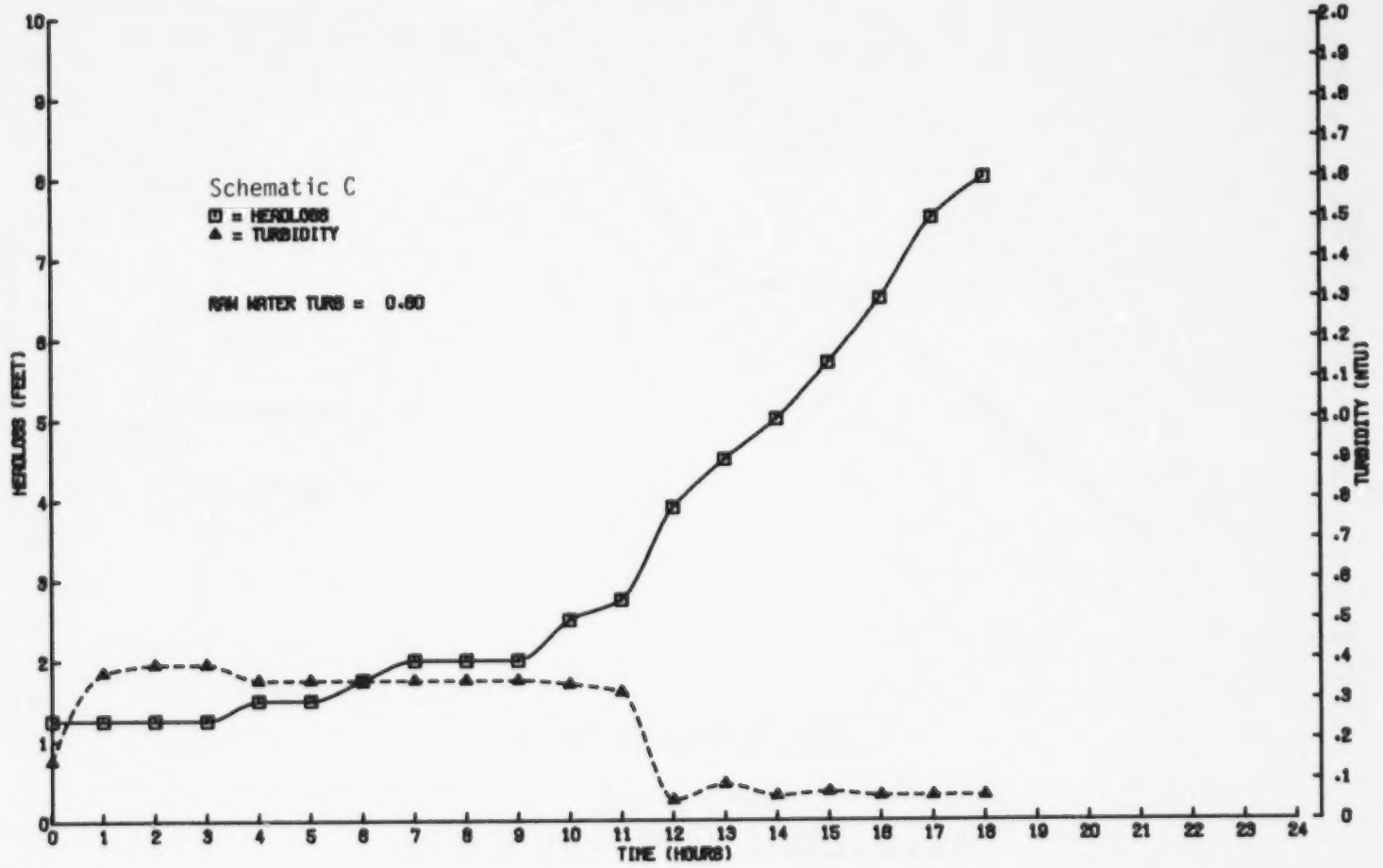
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 35



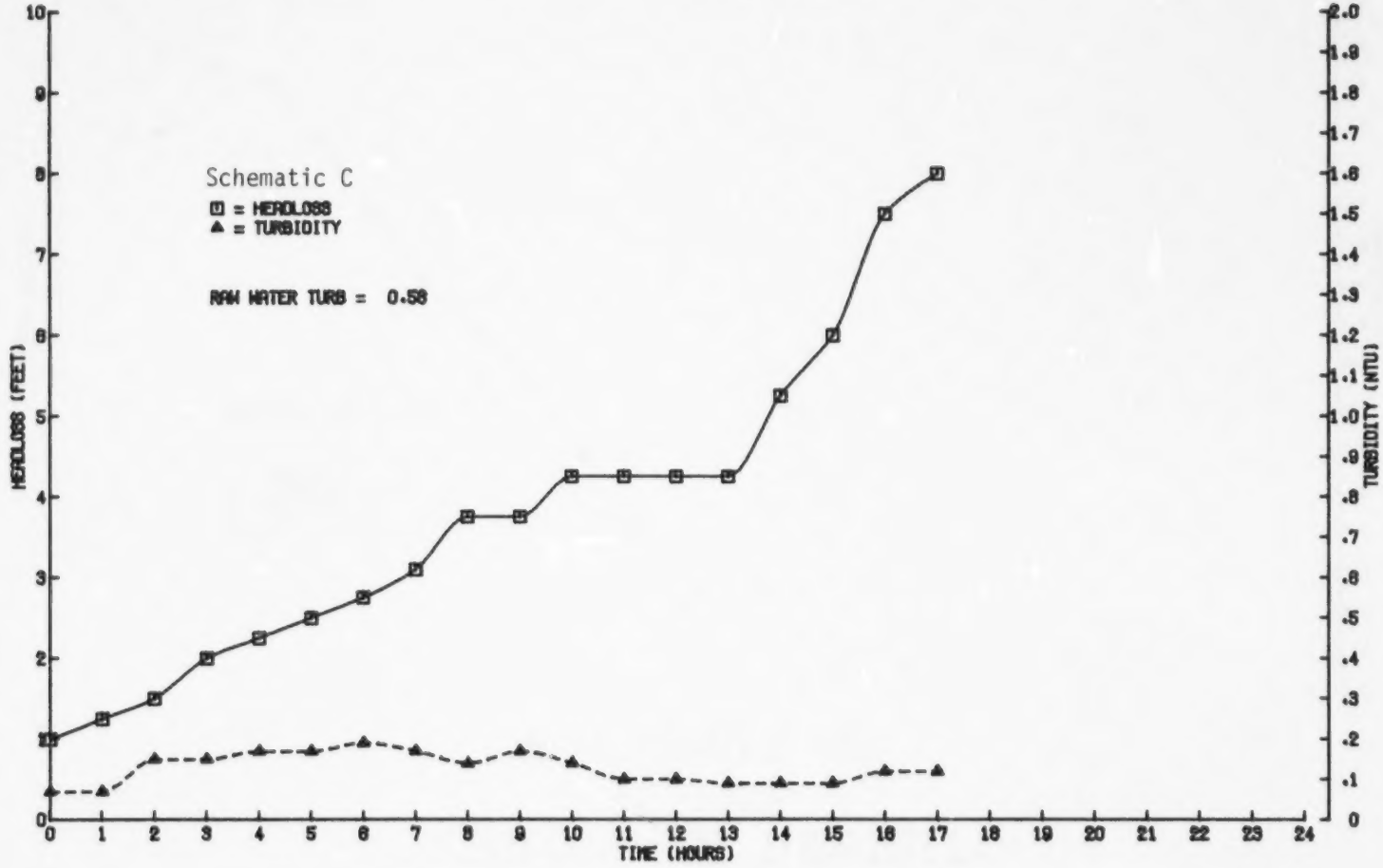
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 37



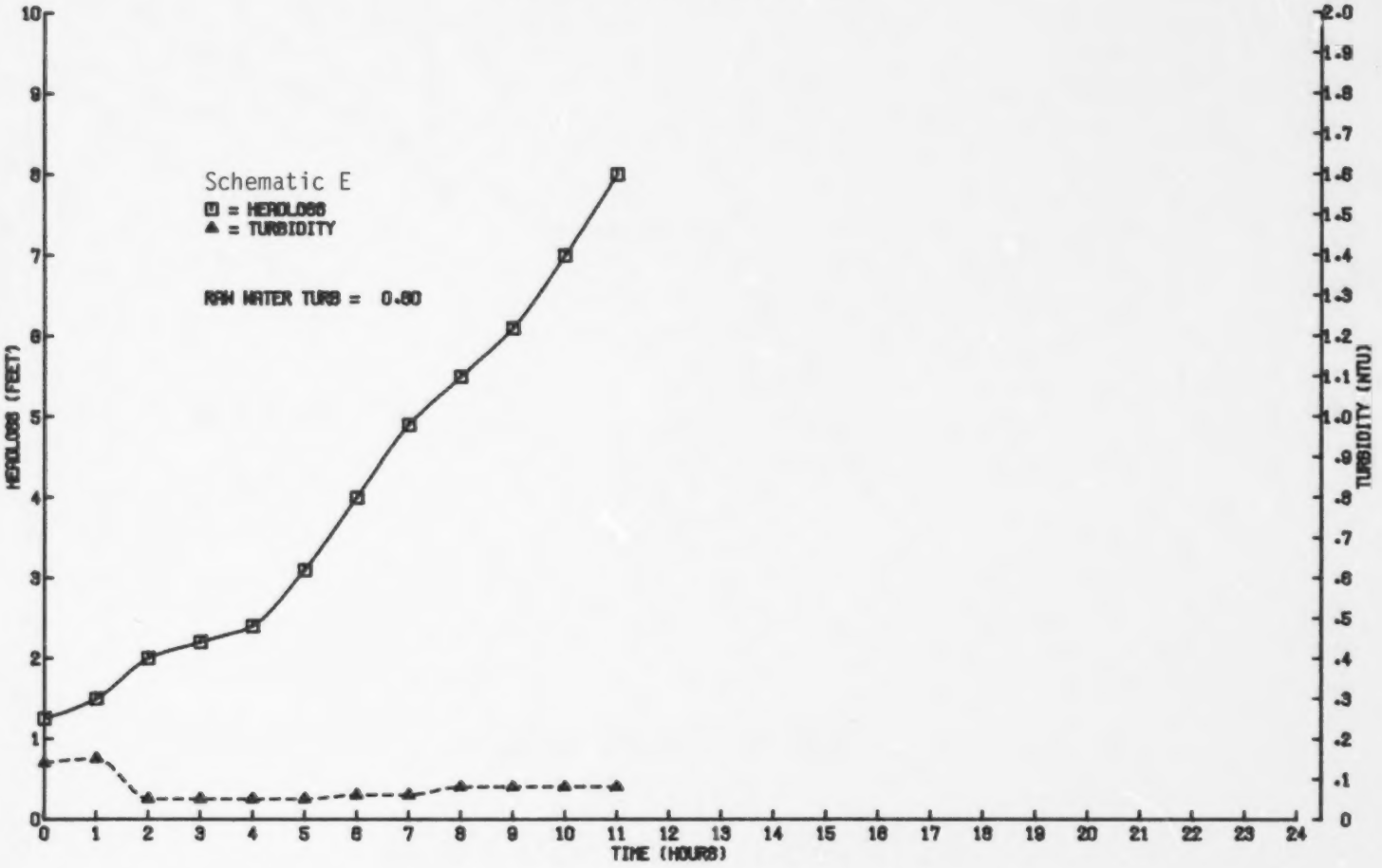
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 38



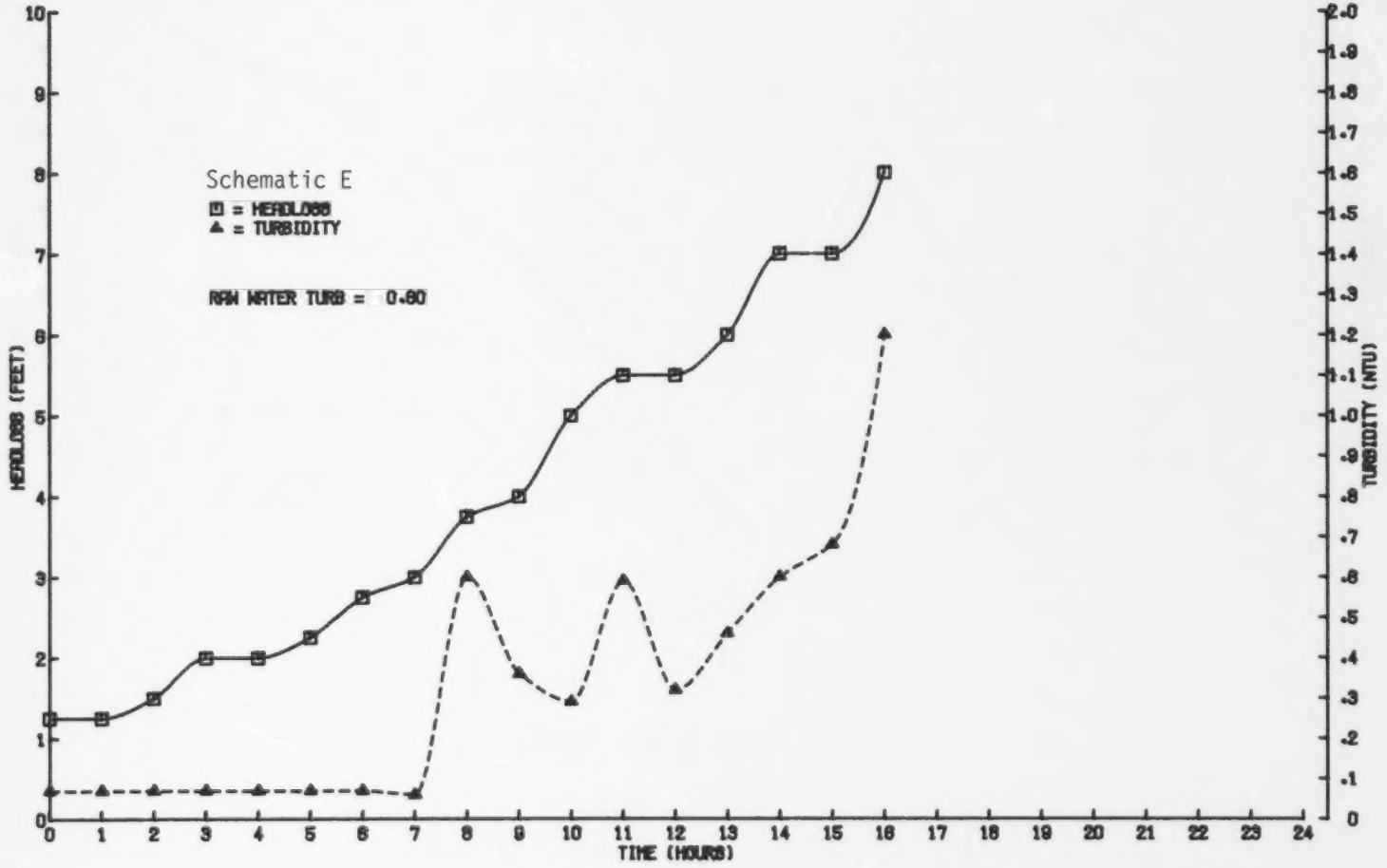
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 39



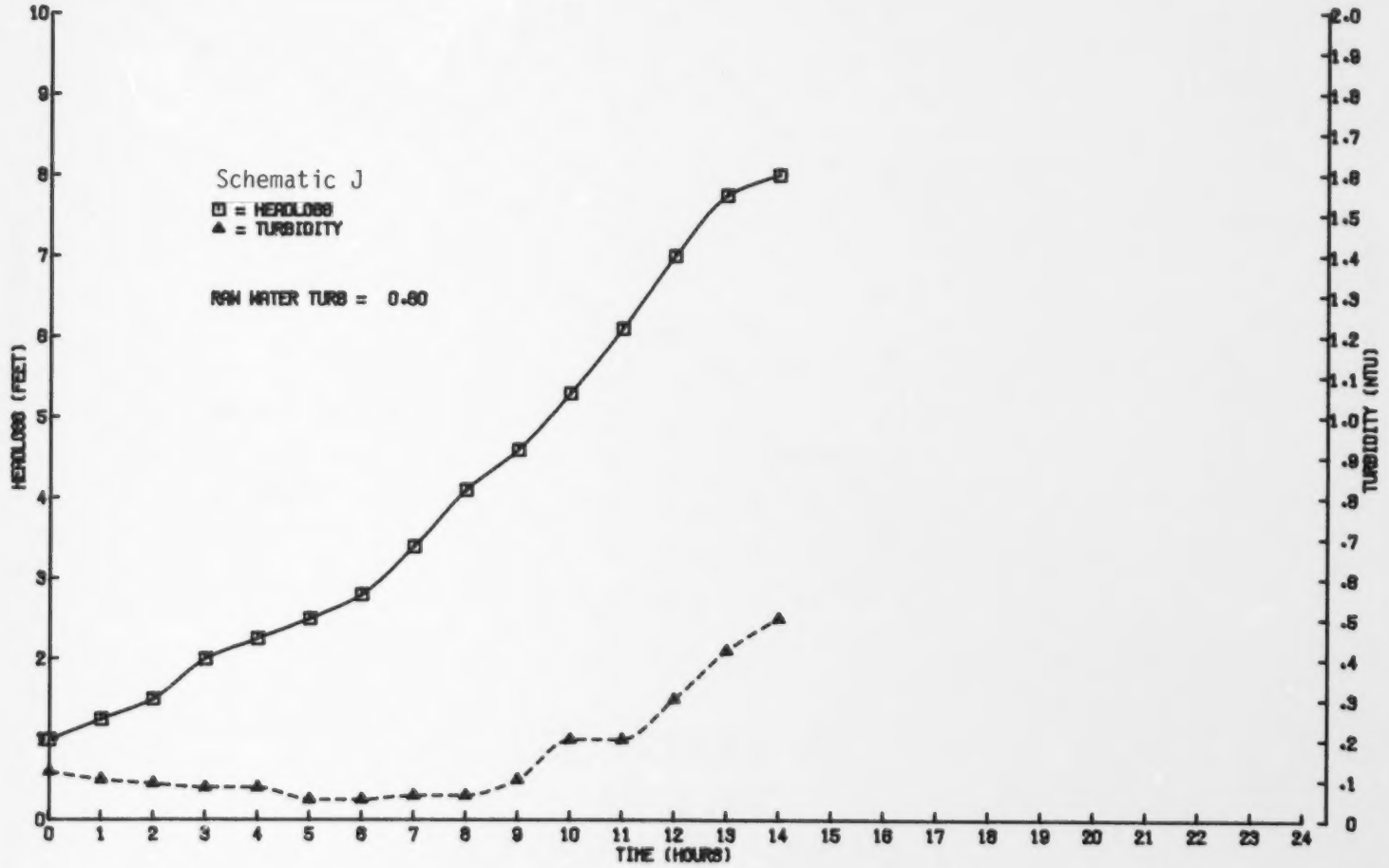
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 40



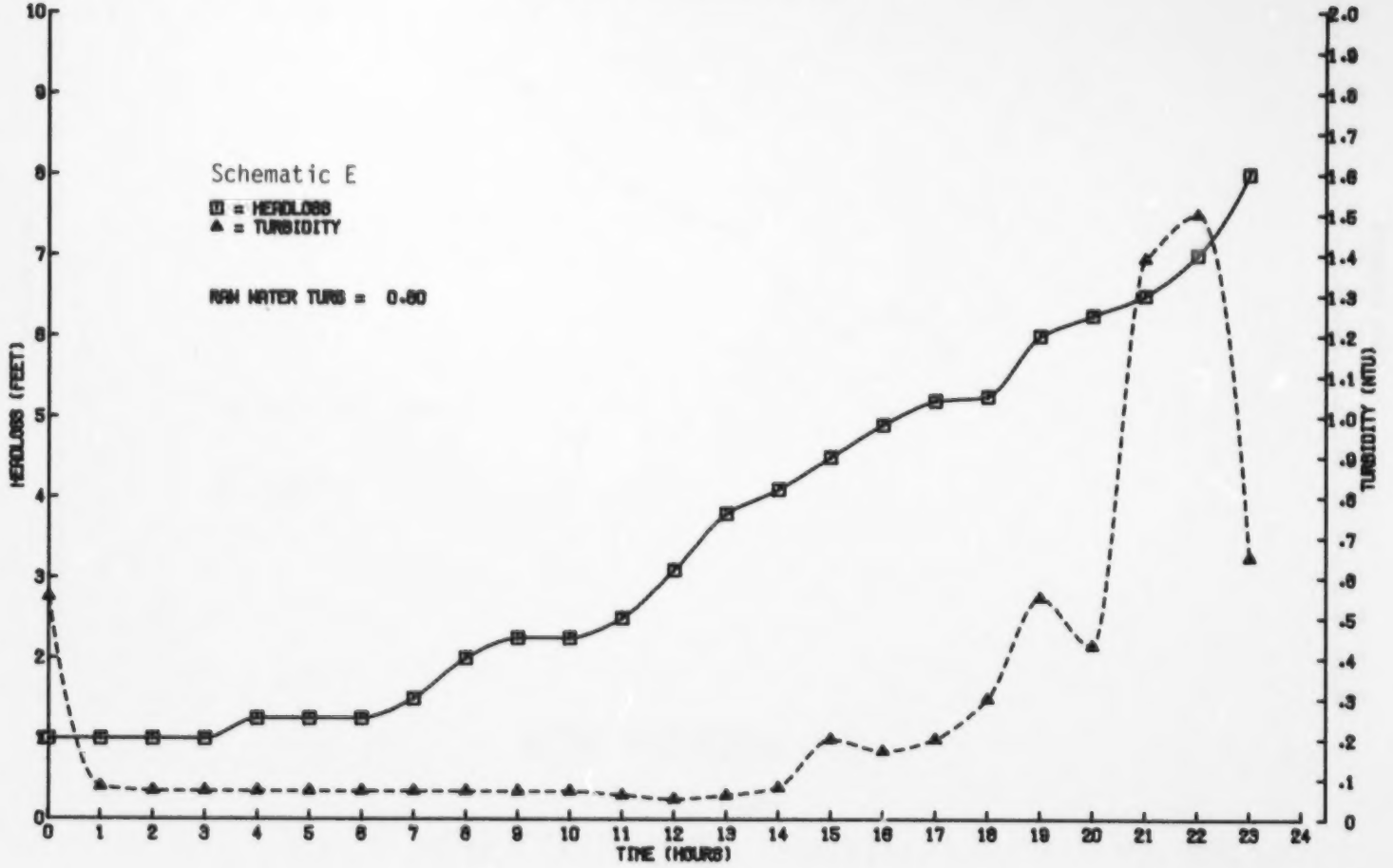
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 41



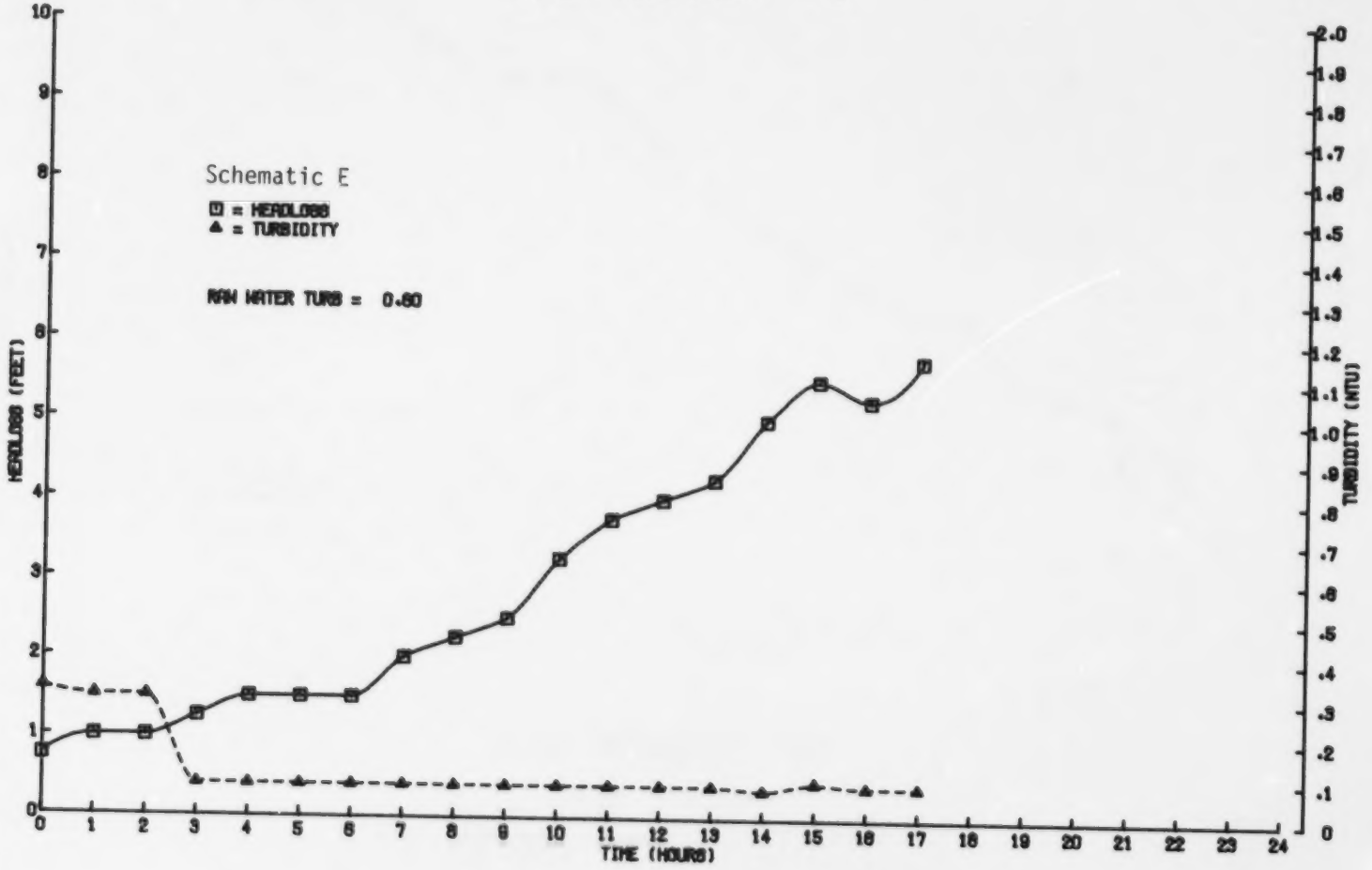
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 42



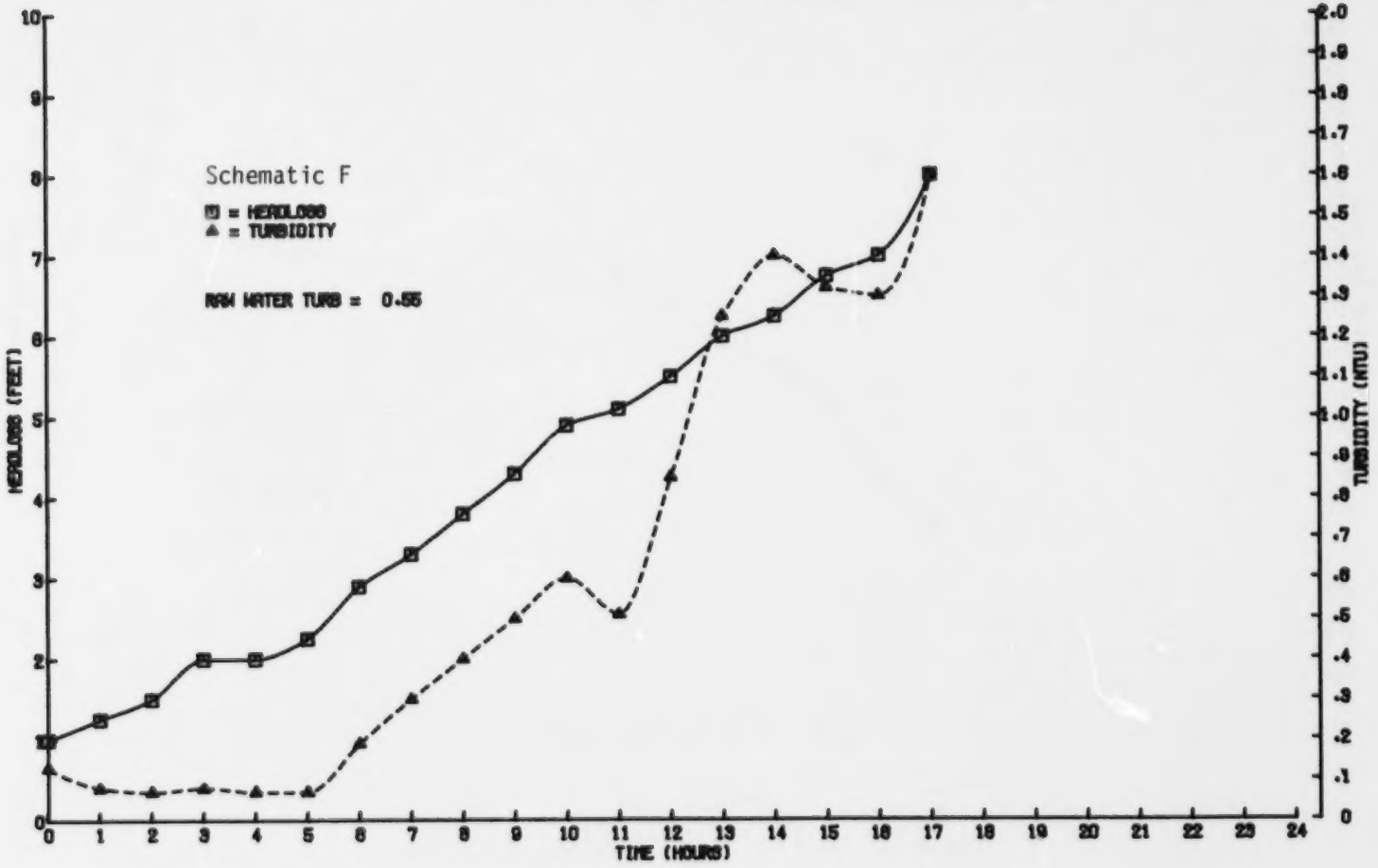
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 44



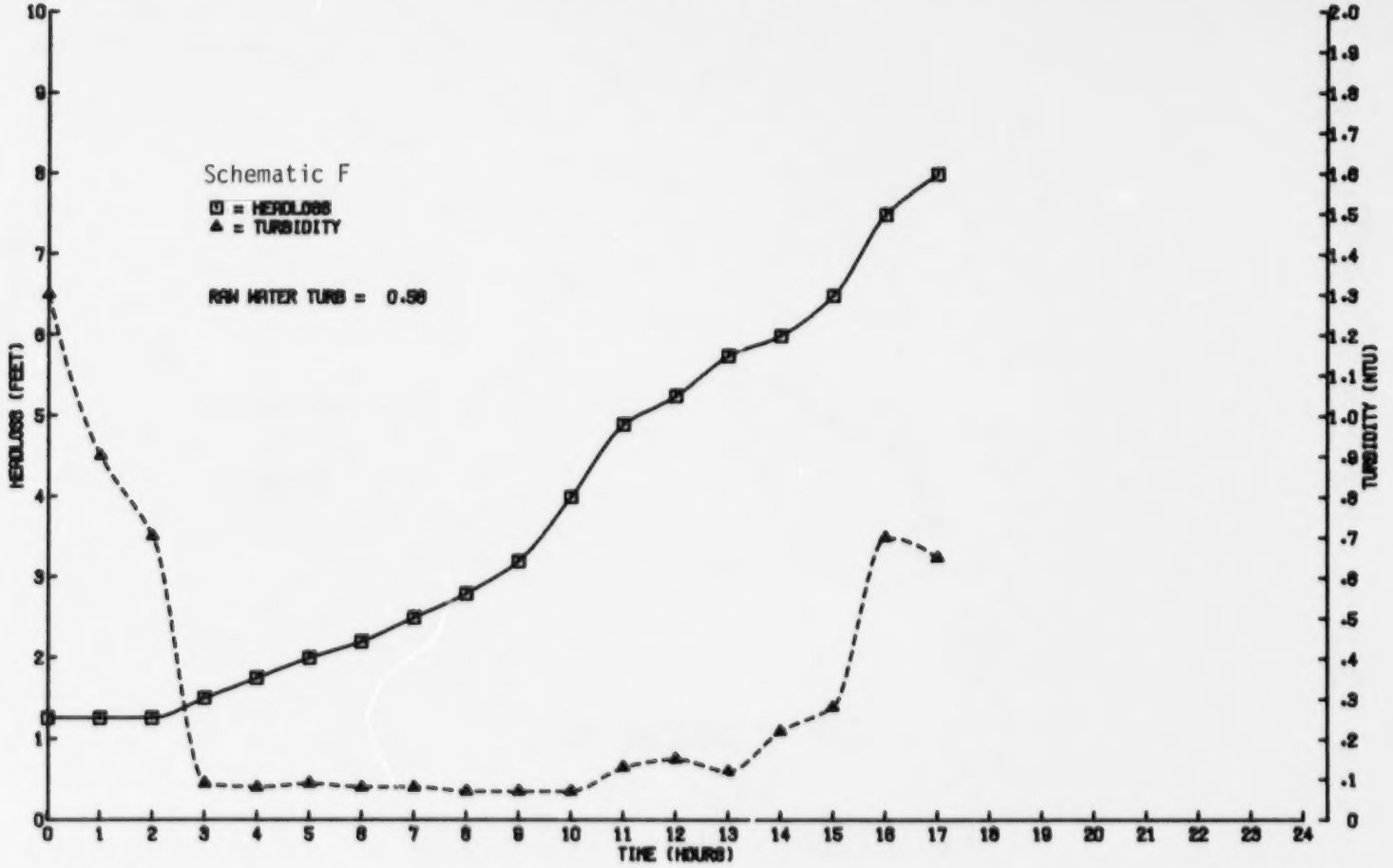
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 45



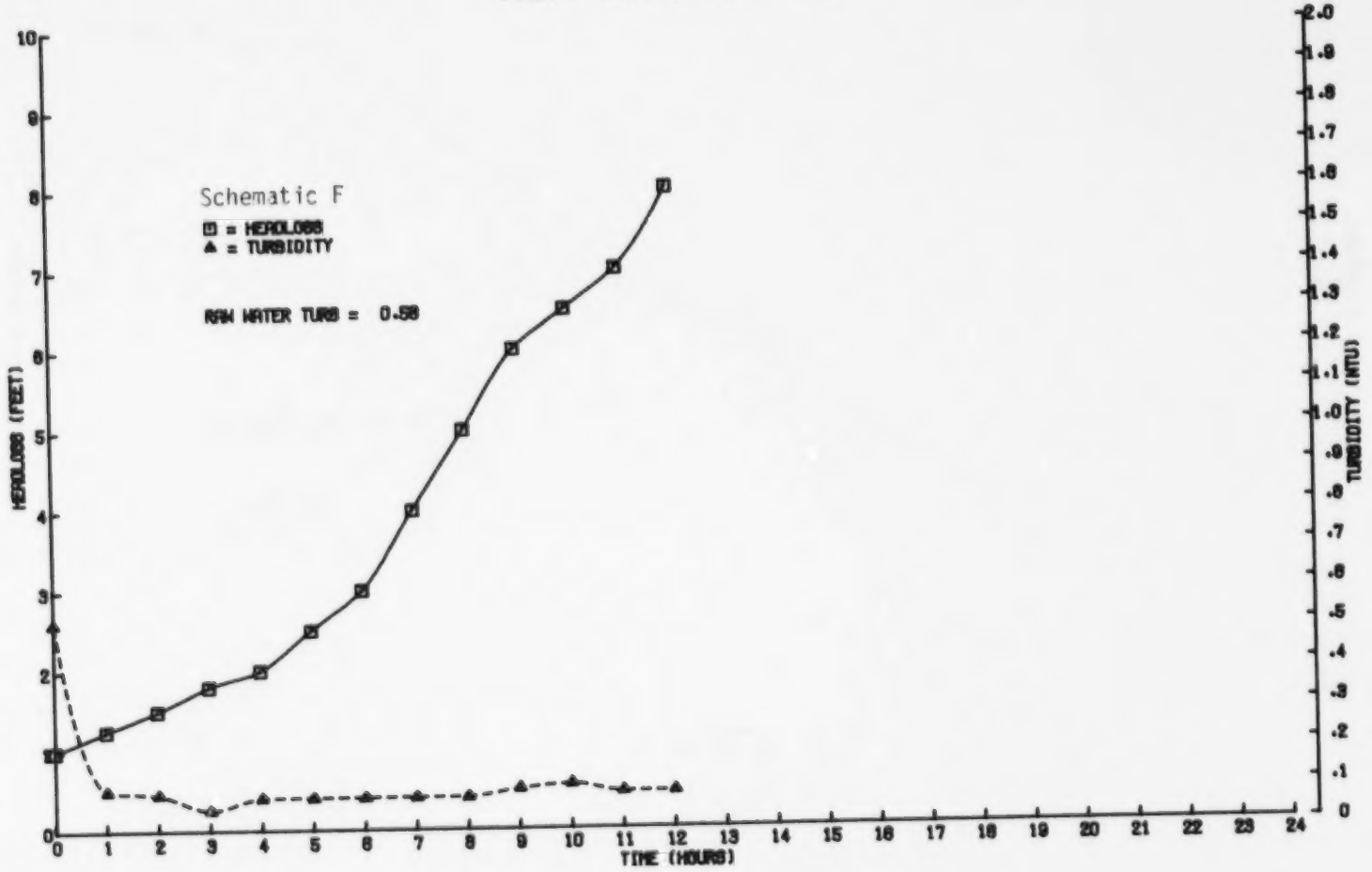
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 46



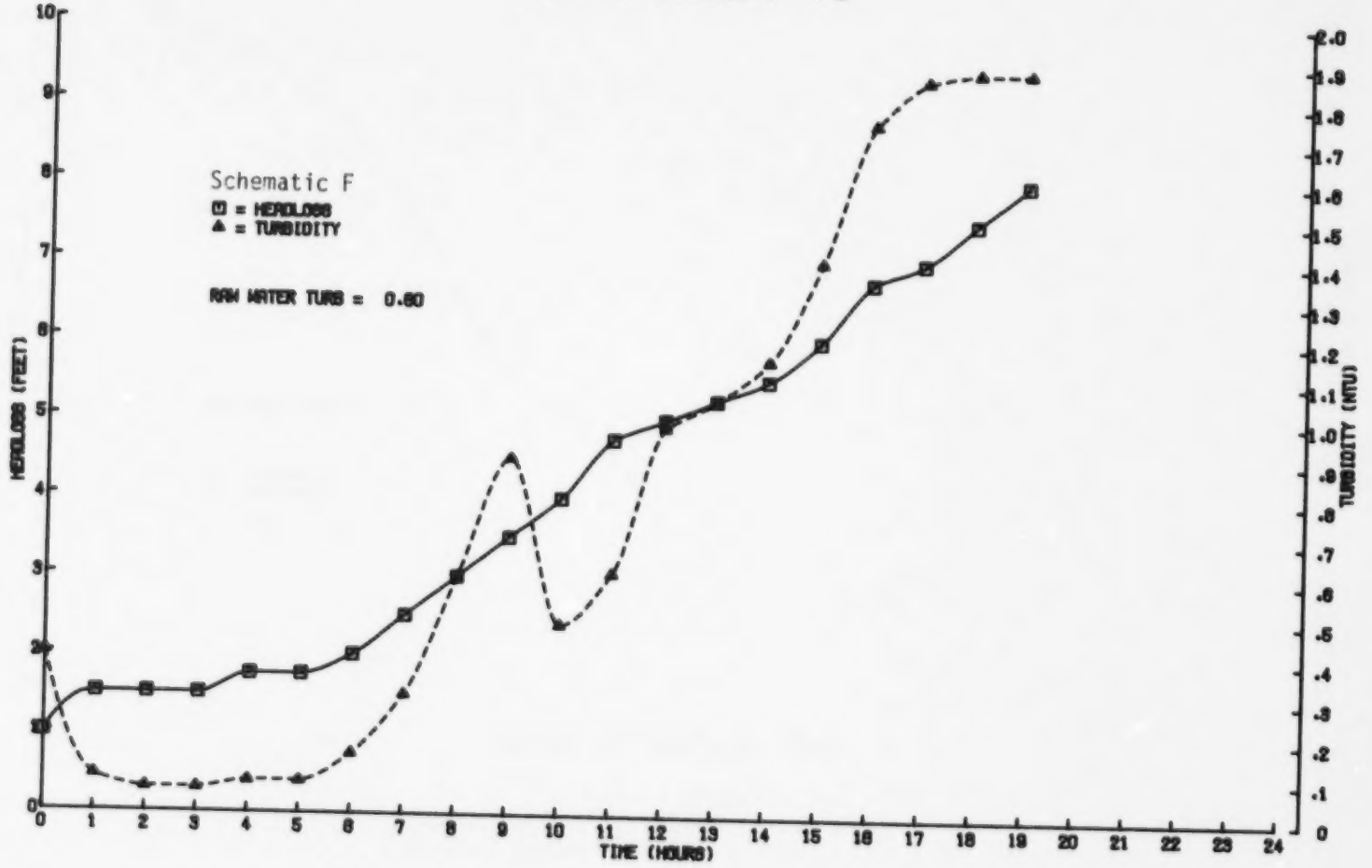
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 47



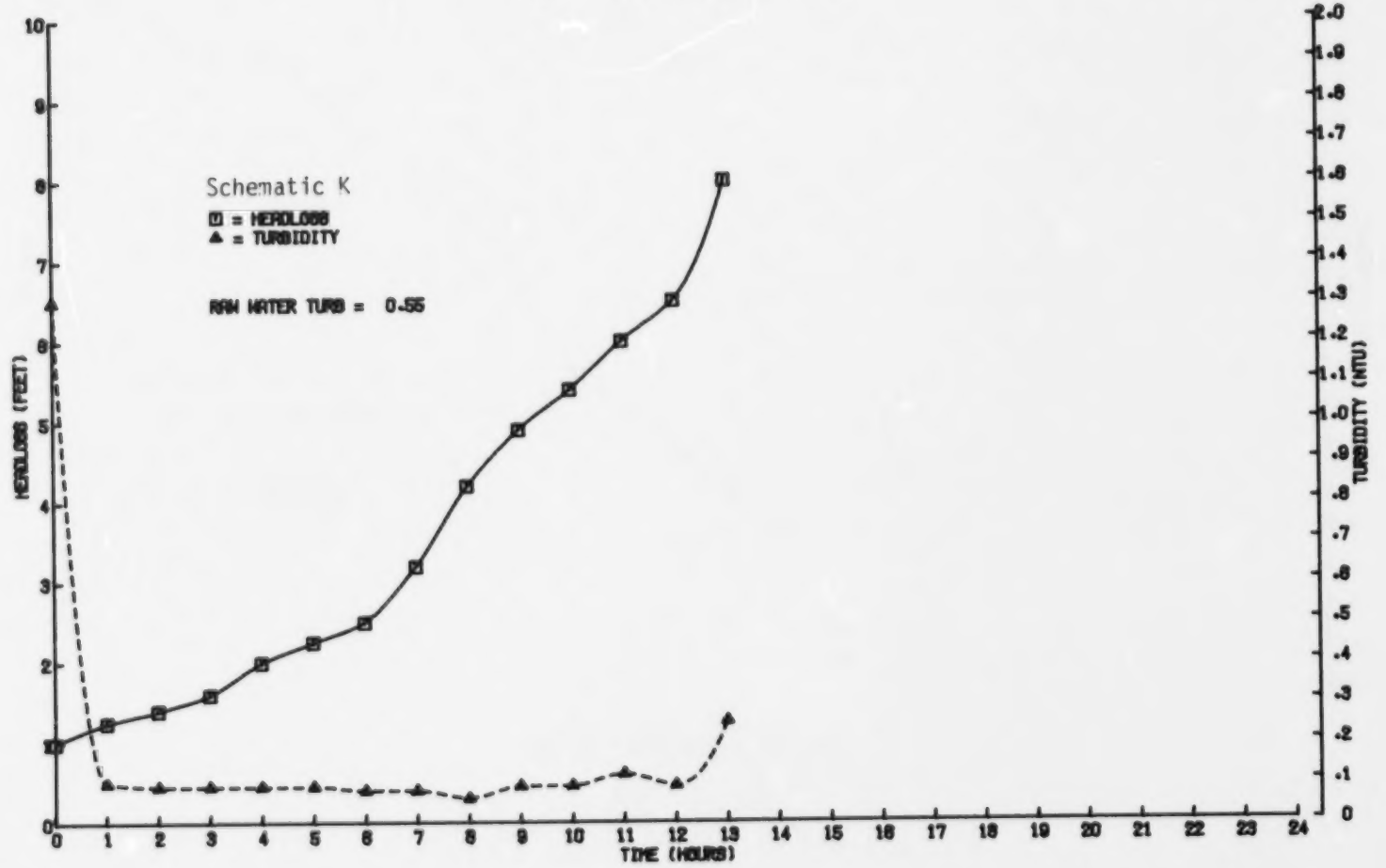
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 48



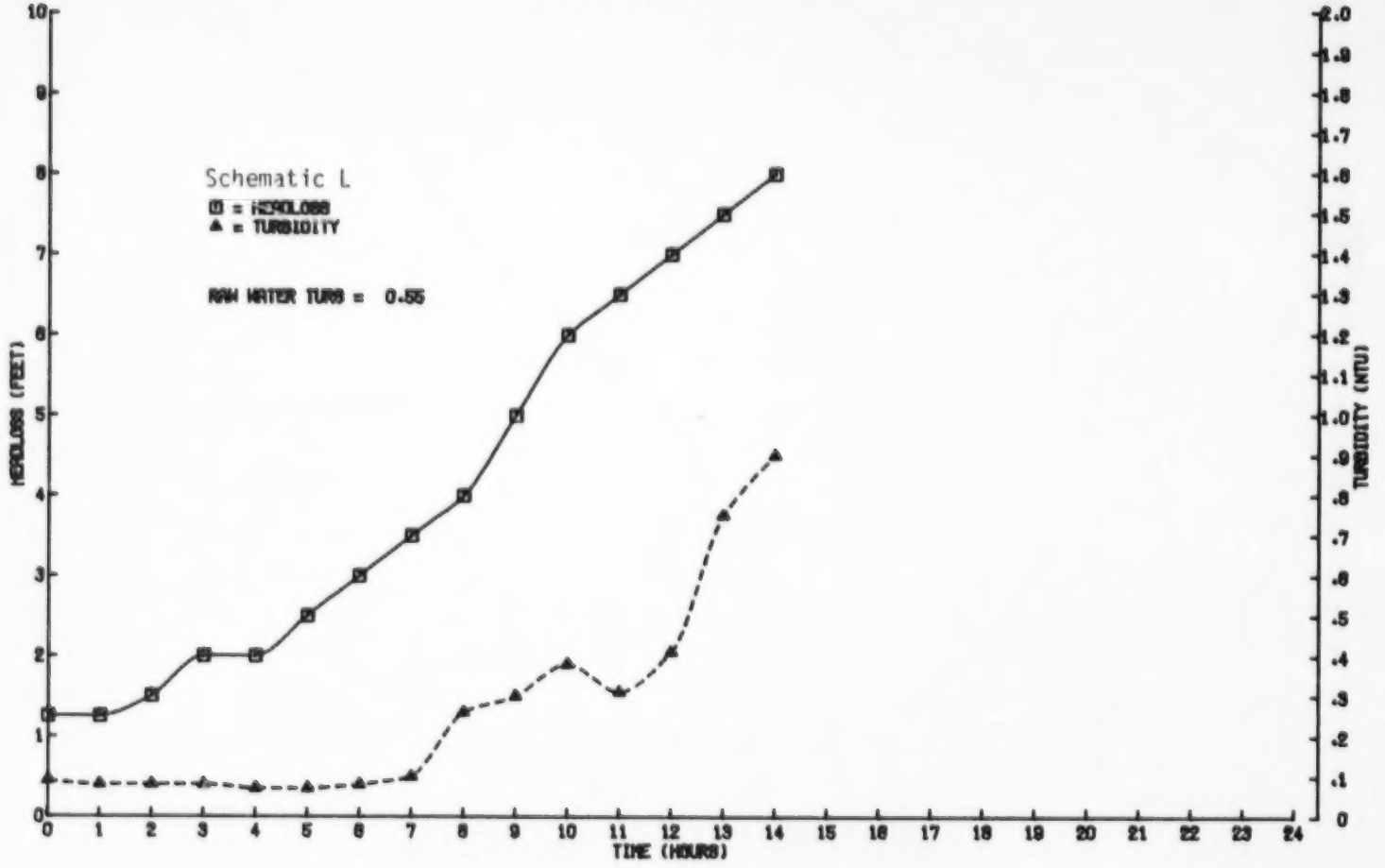
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 49



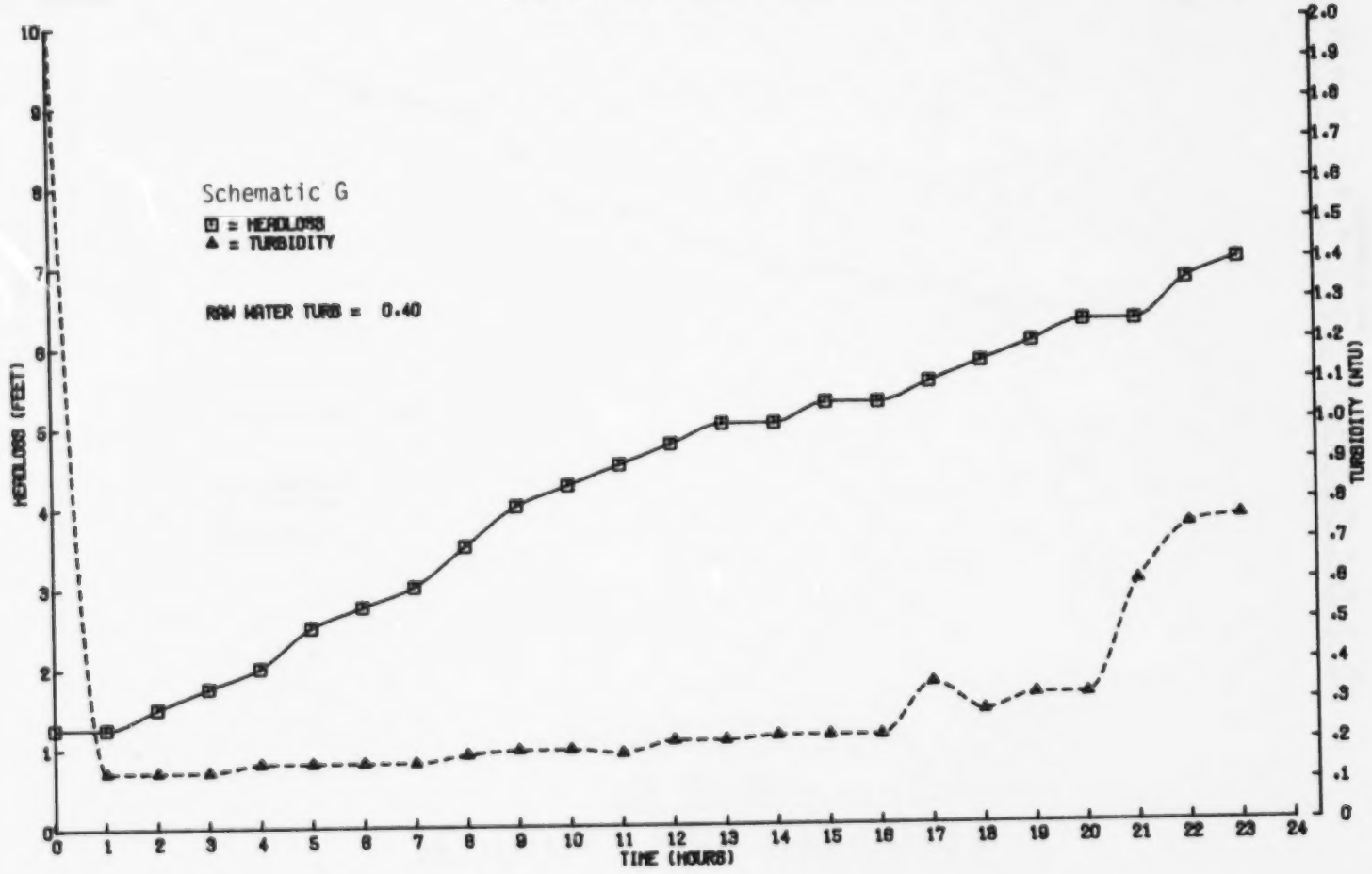
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 50



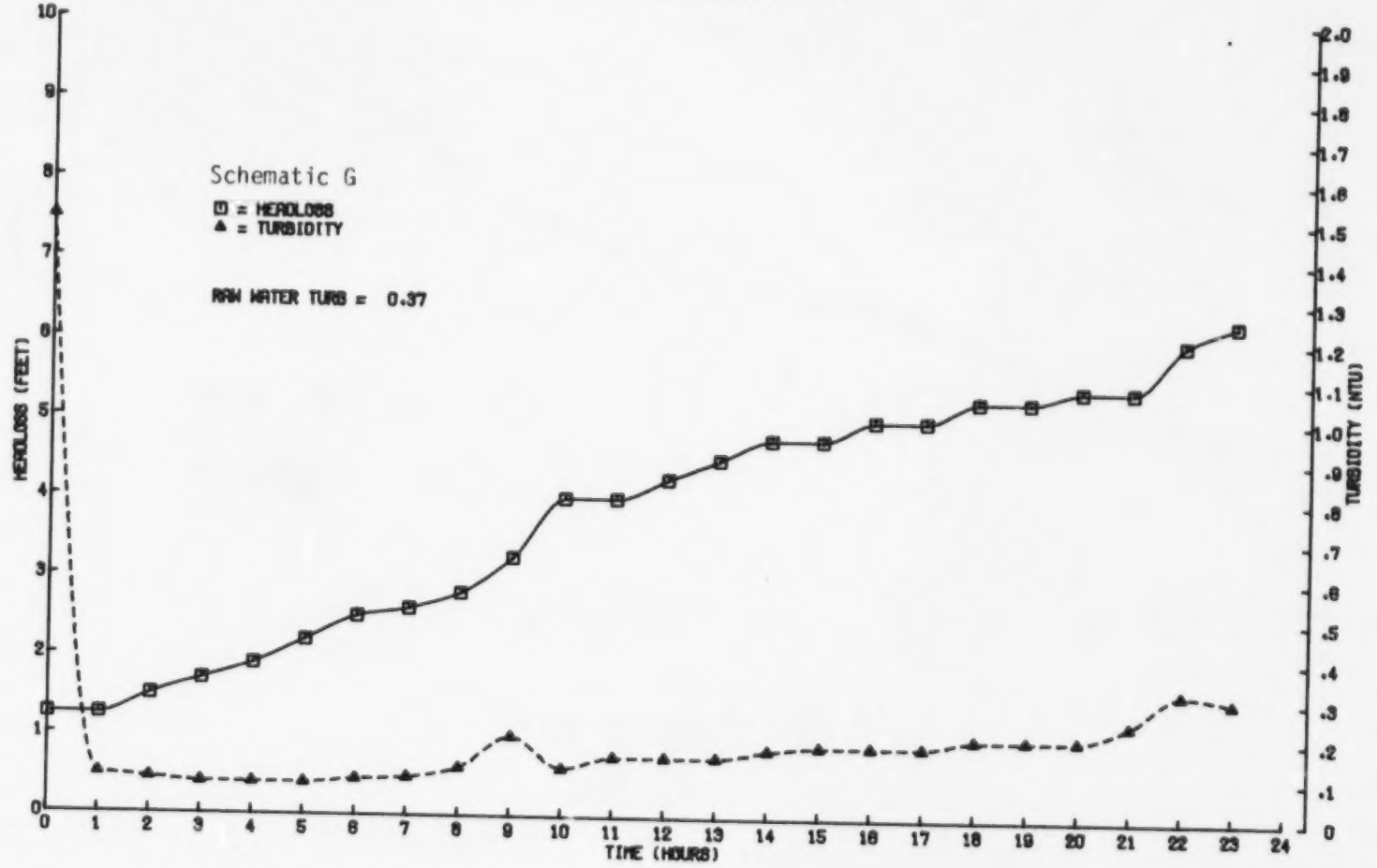
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 51



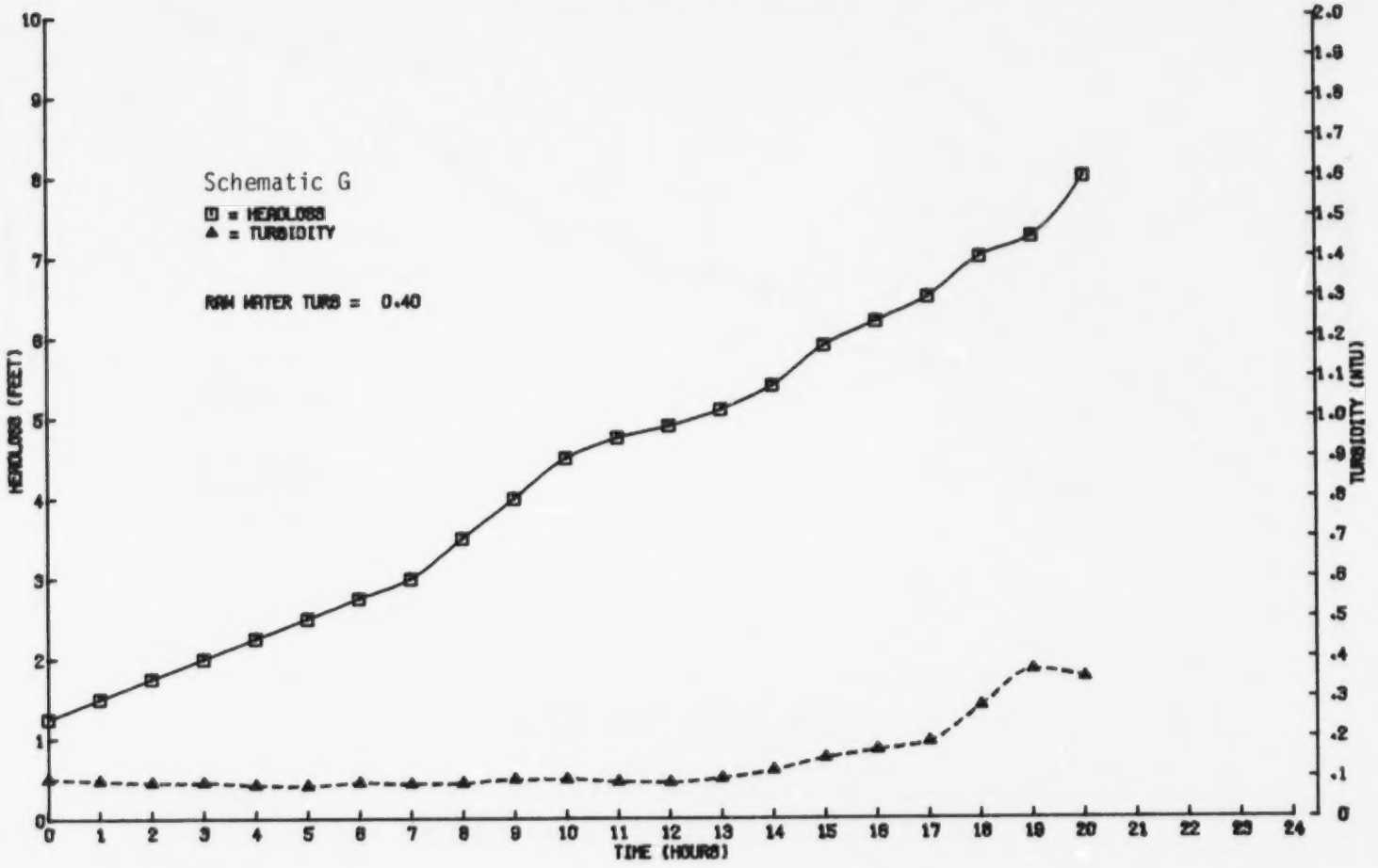
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 60



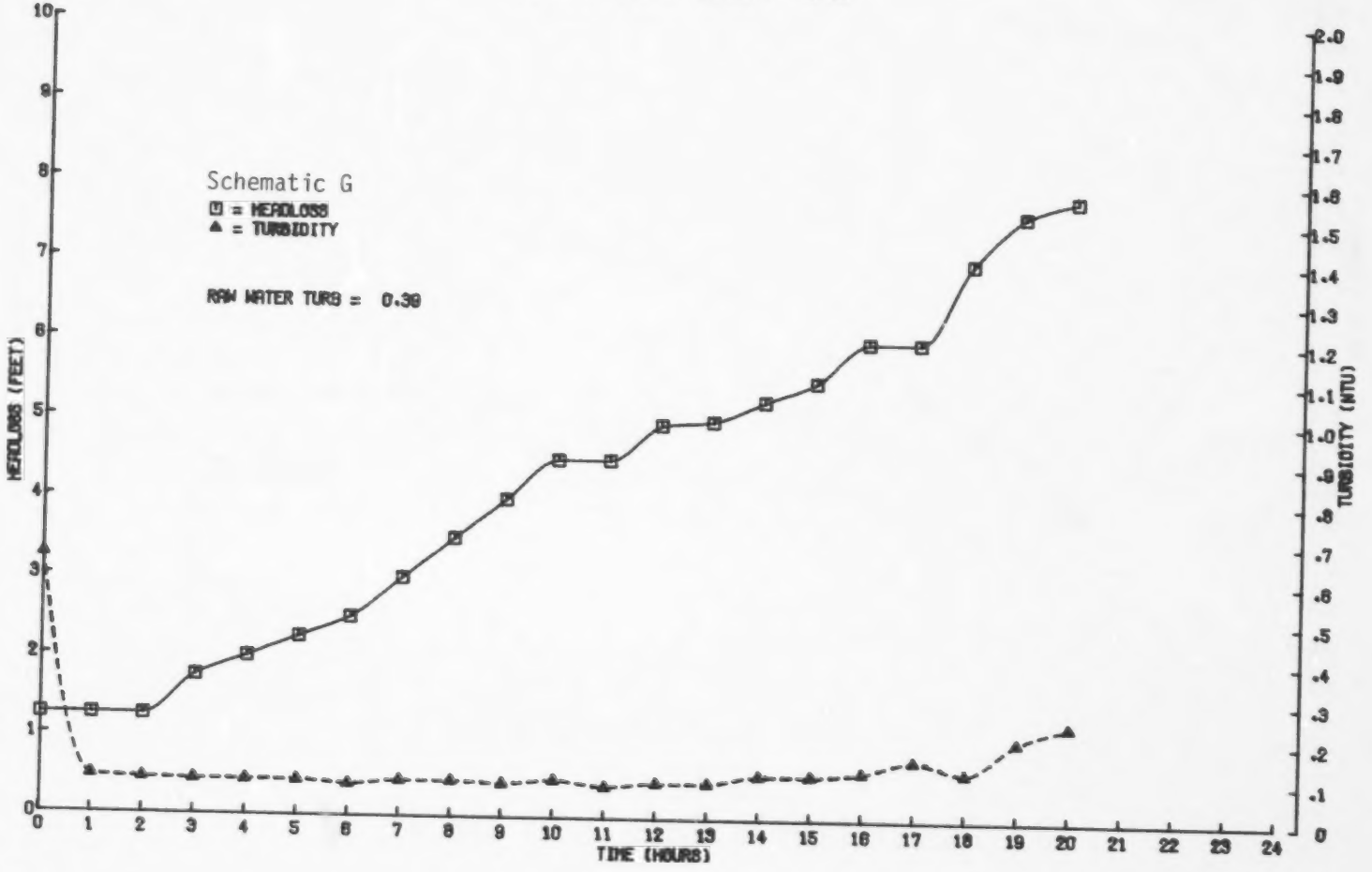
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 61



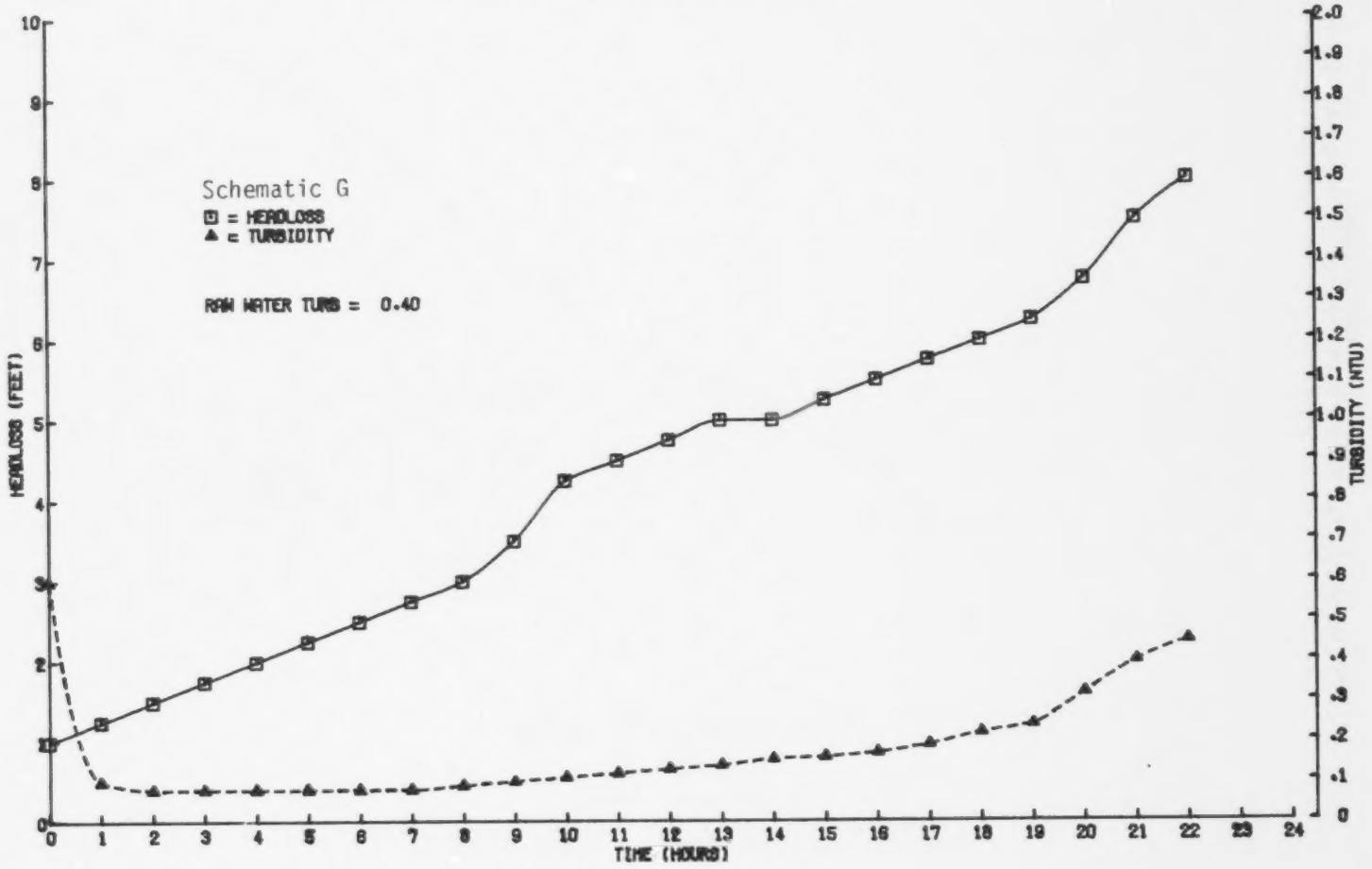
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 62



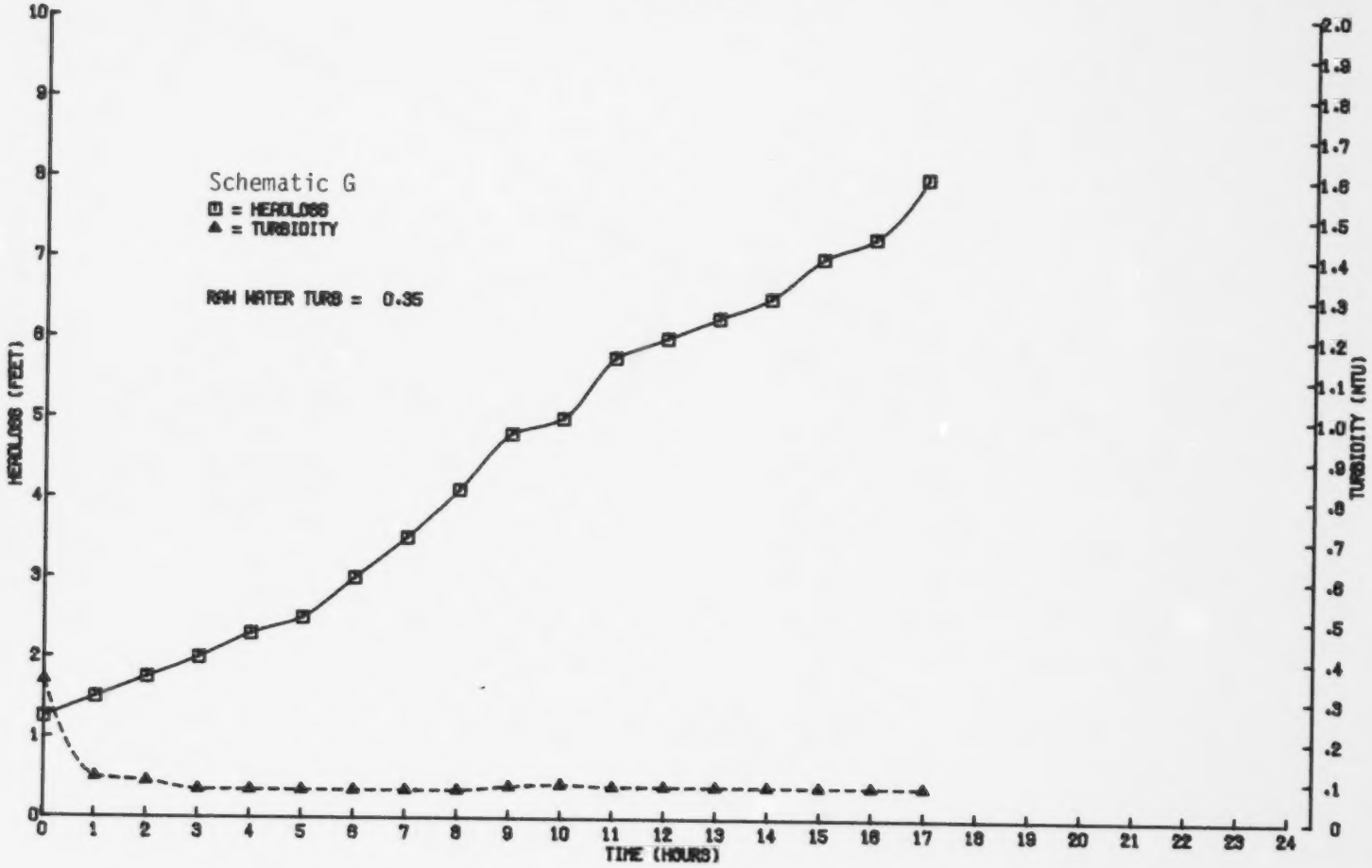
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 63



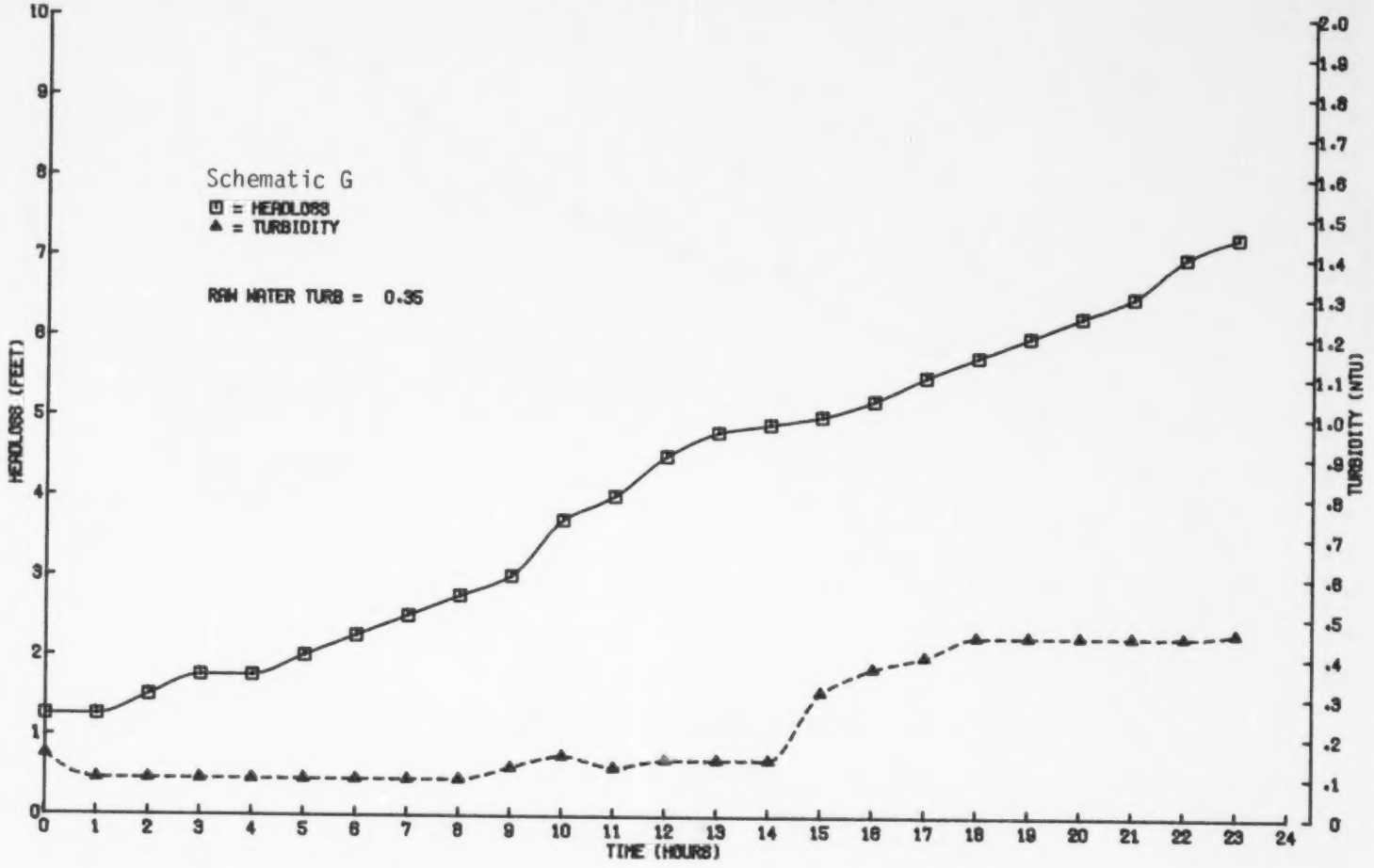
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 64



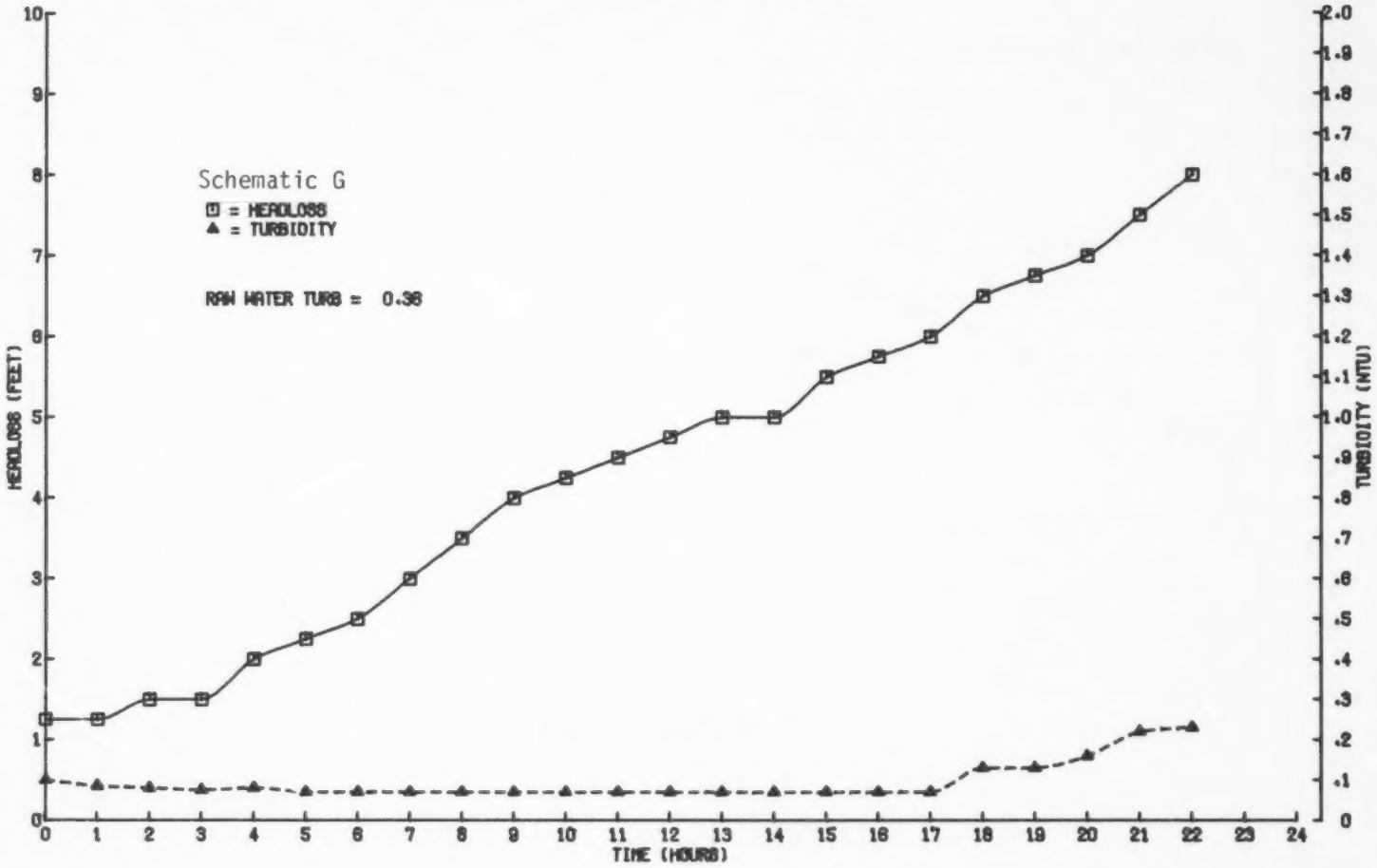
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 65



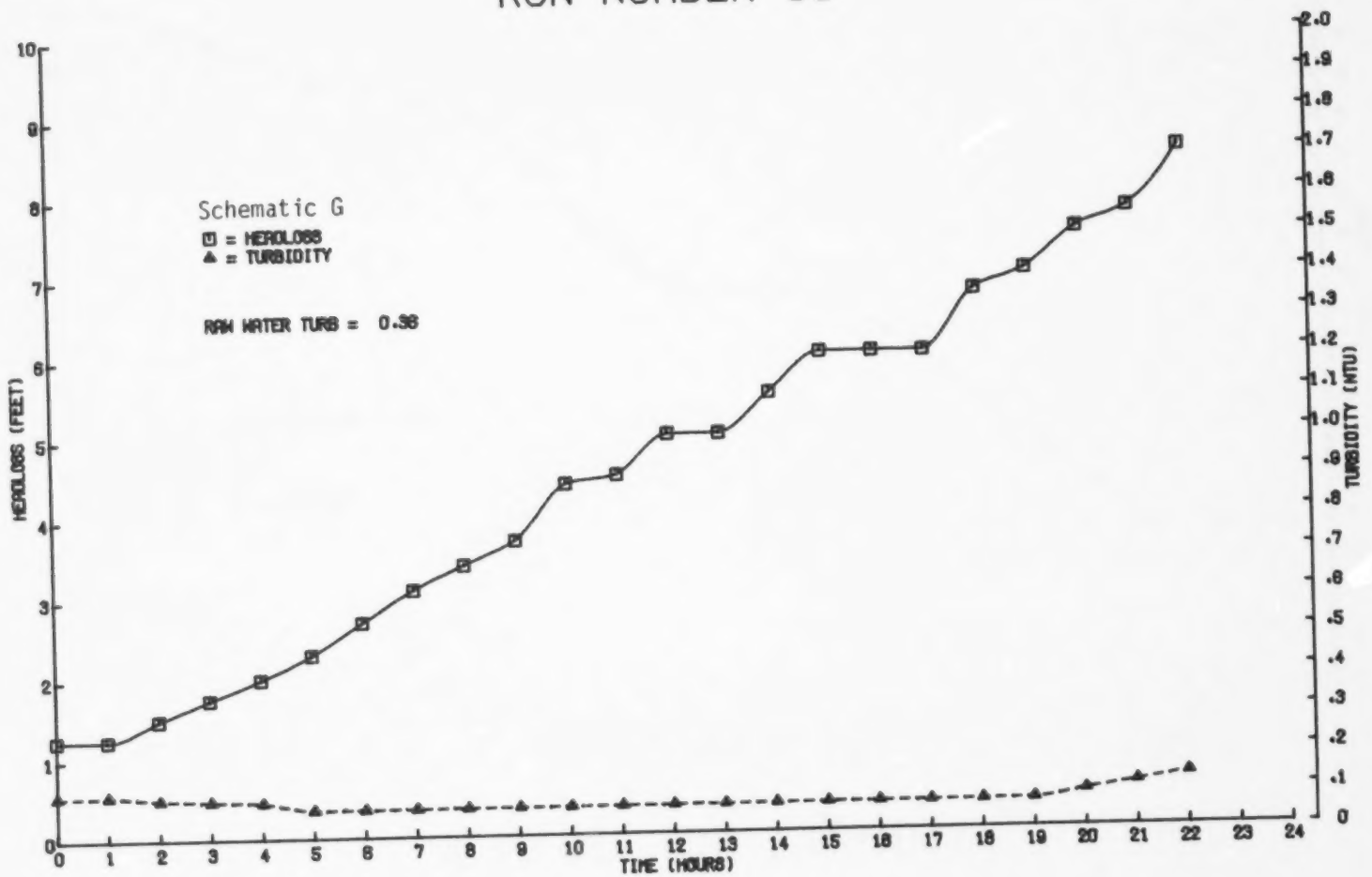
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 66



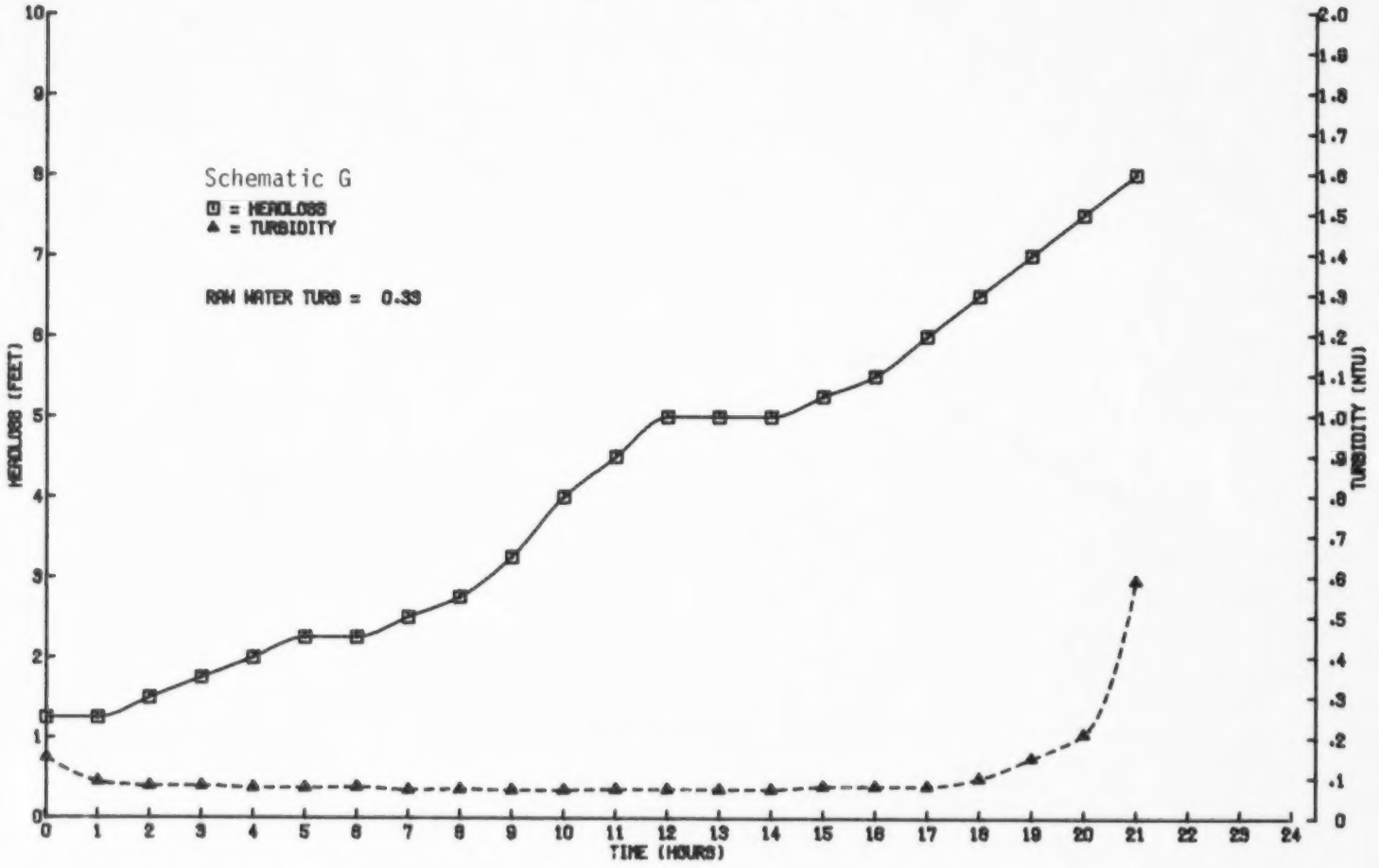
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 68



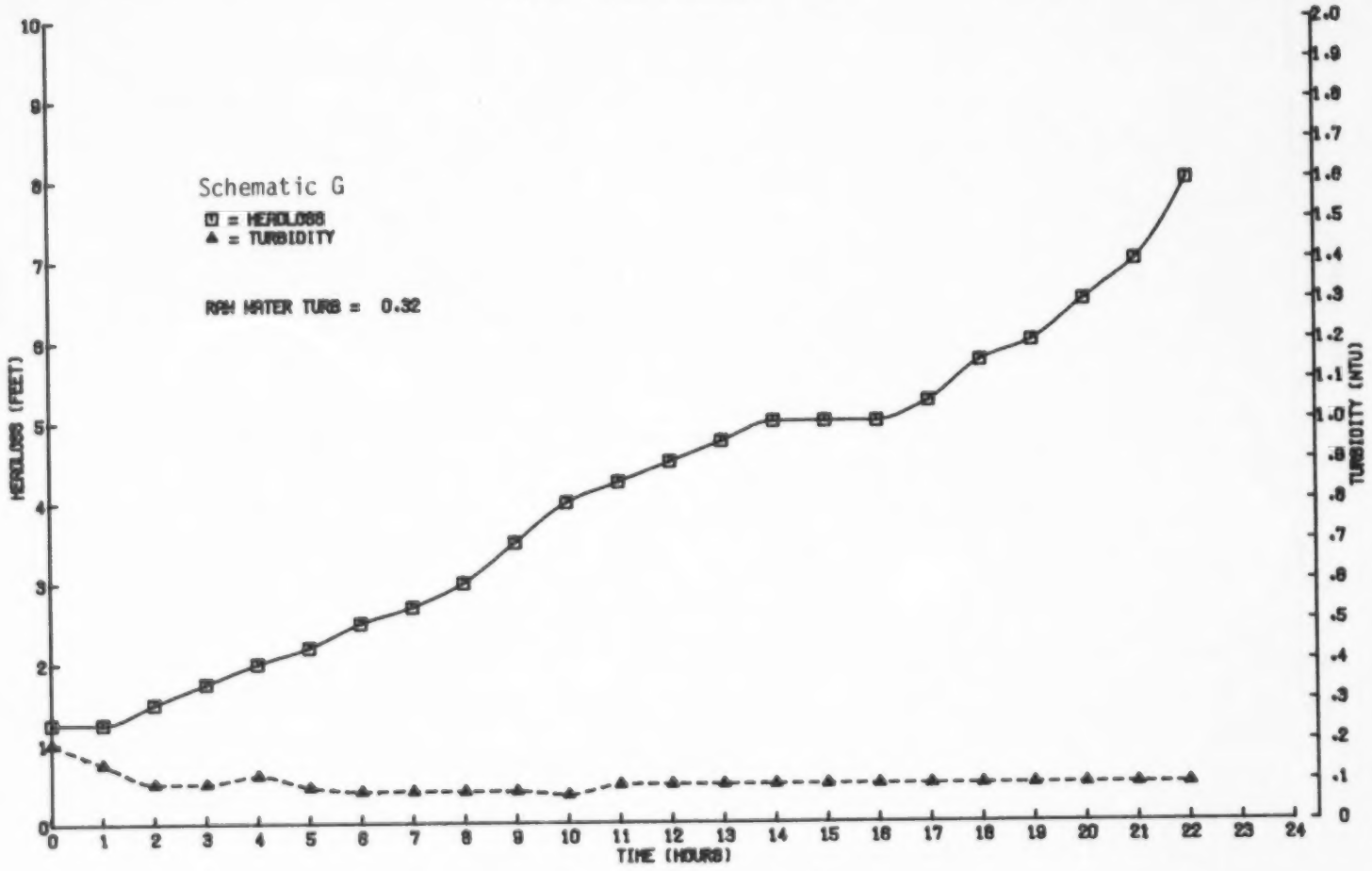
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 69



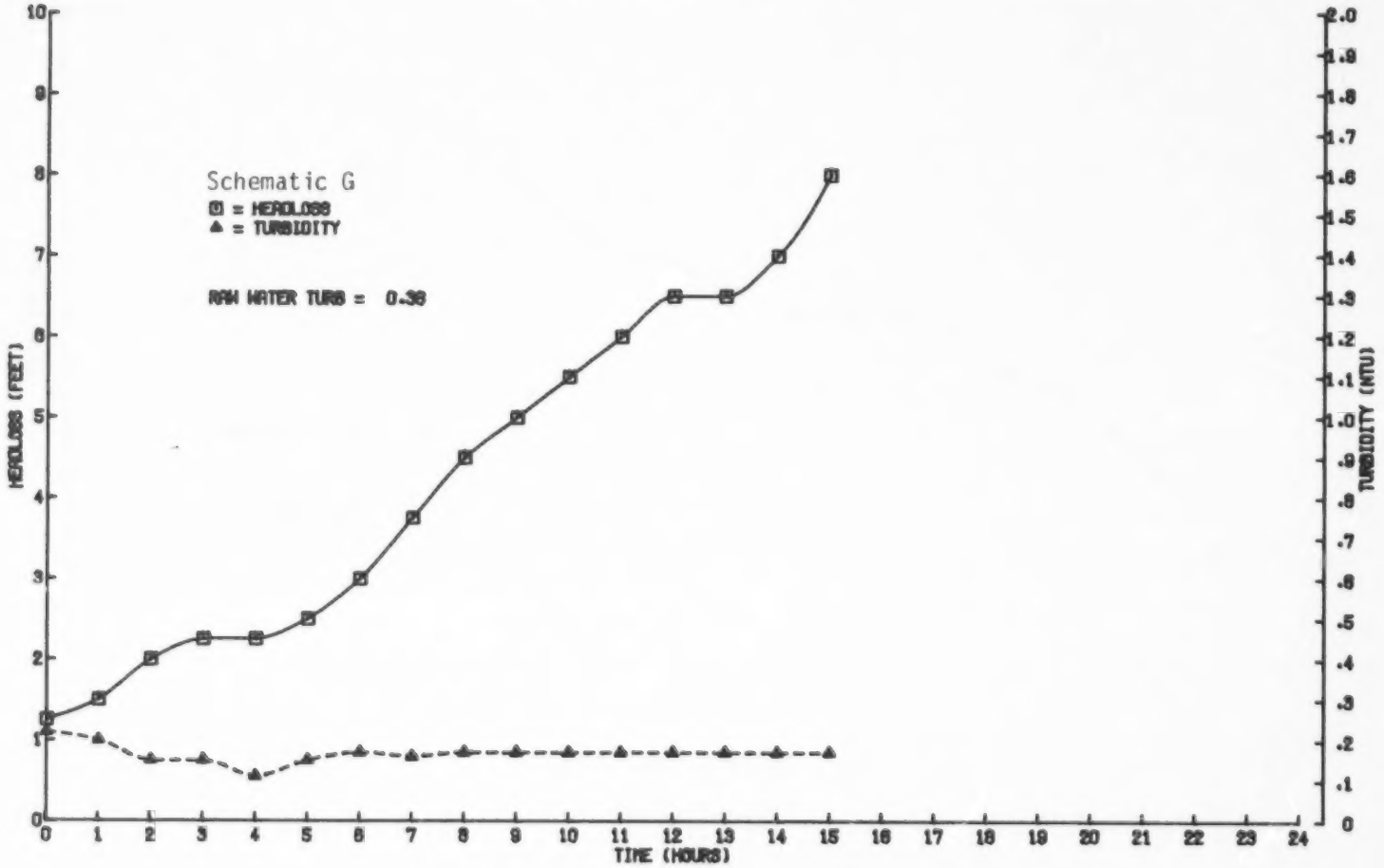
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 70



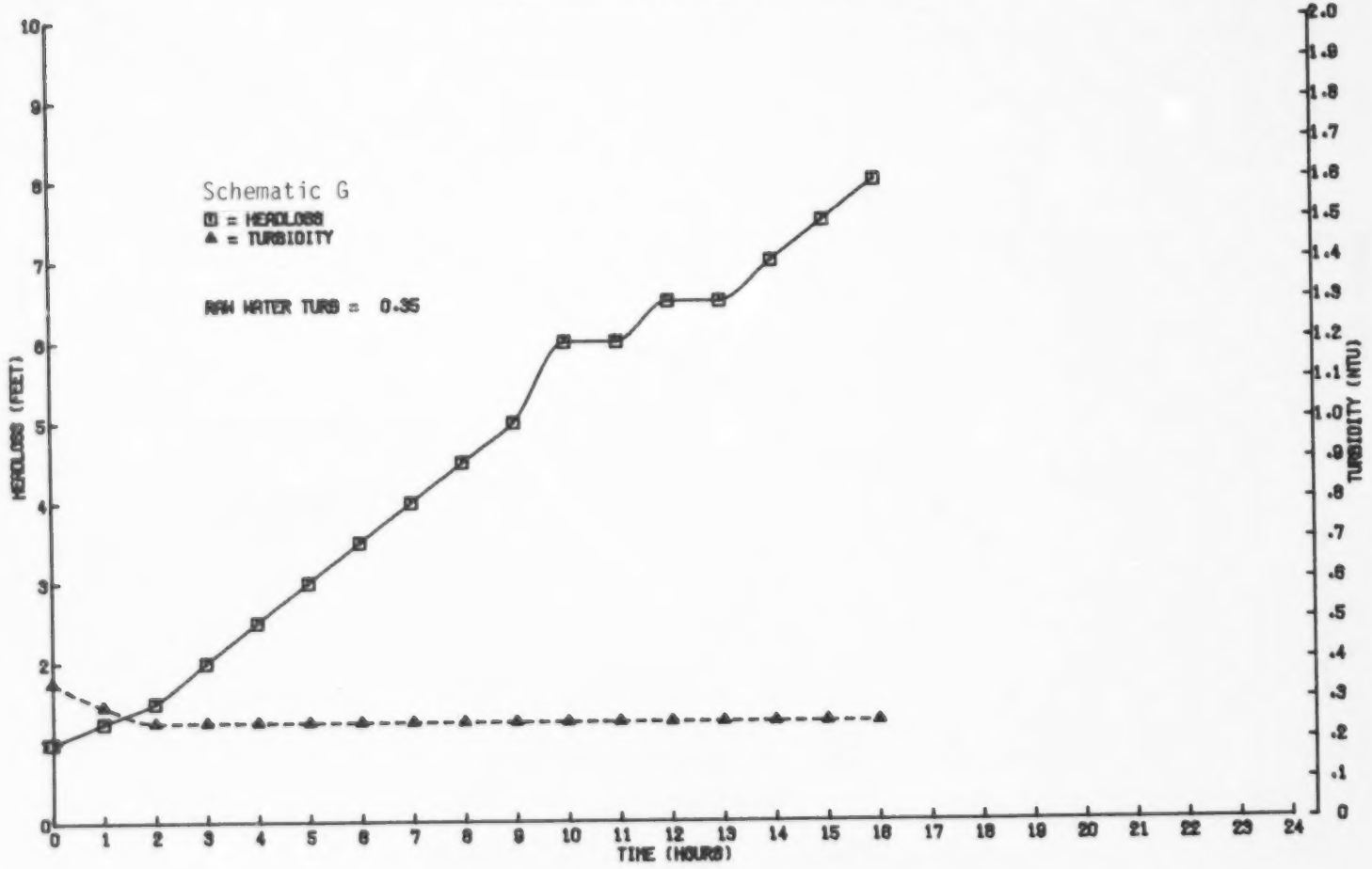
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 71



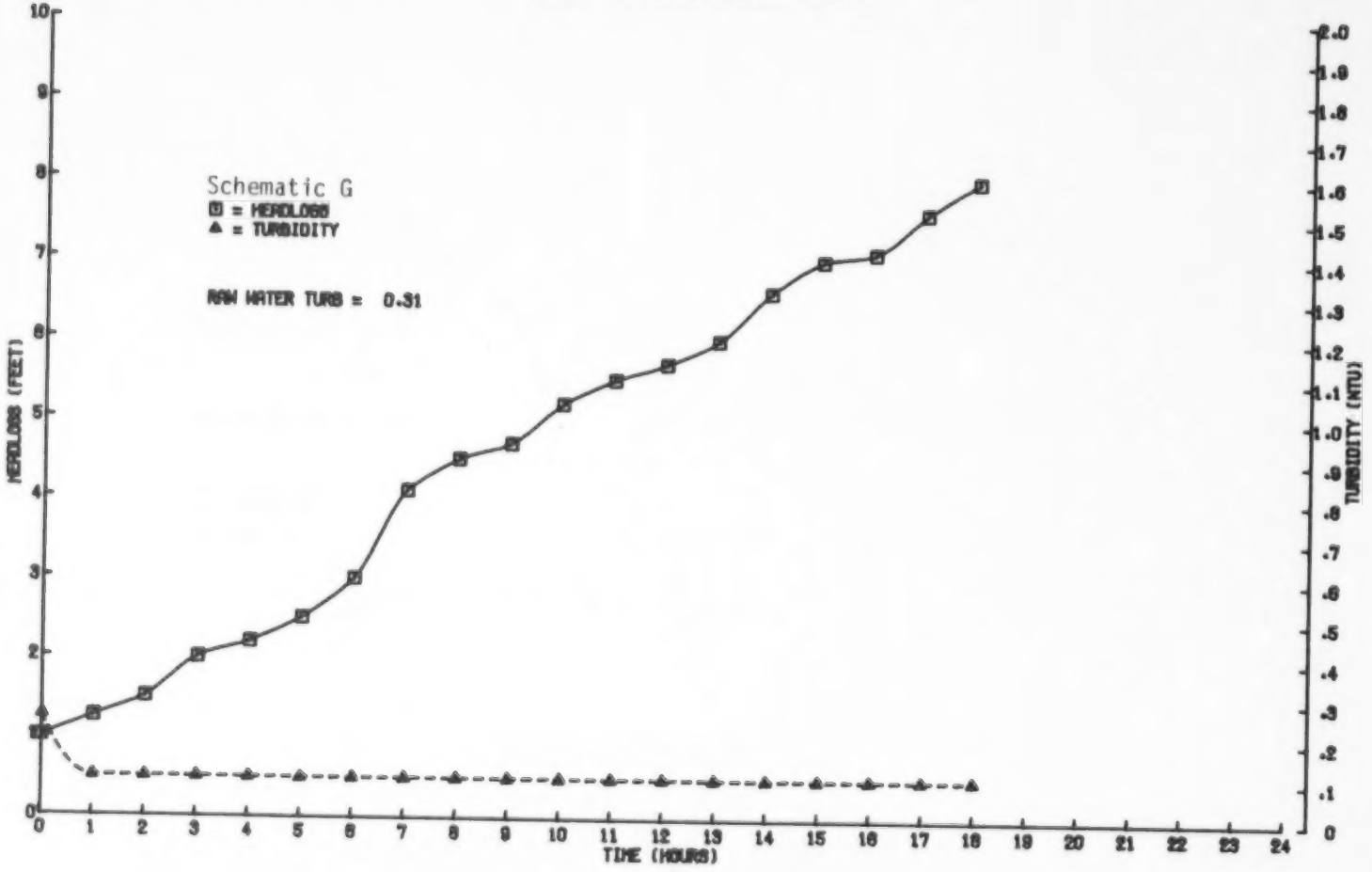
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 74



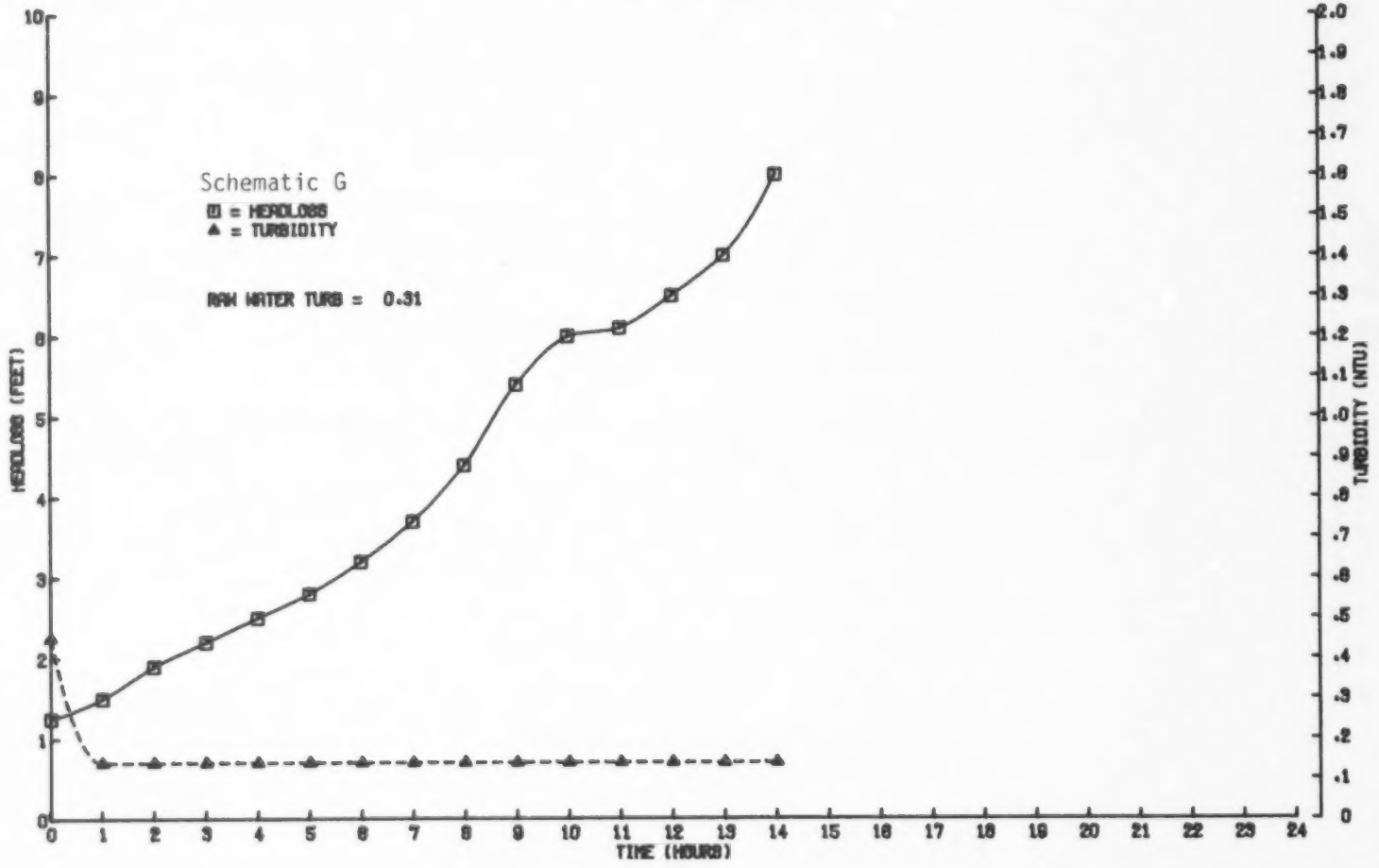
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 75



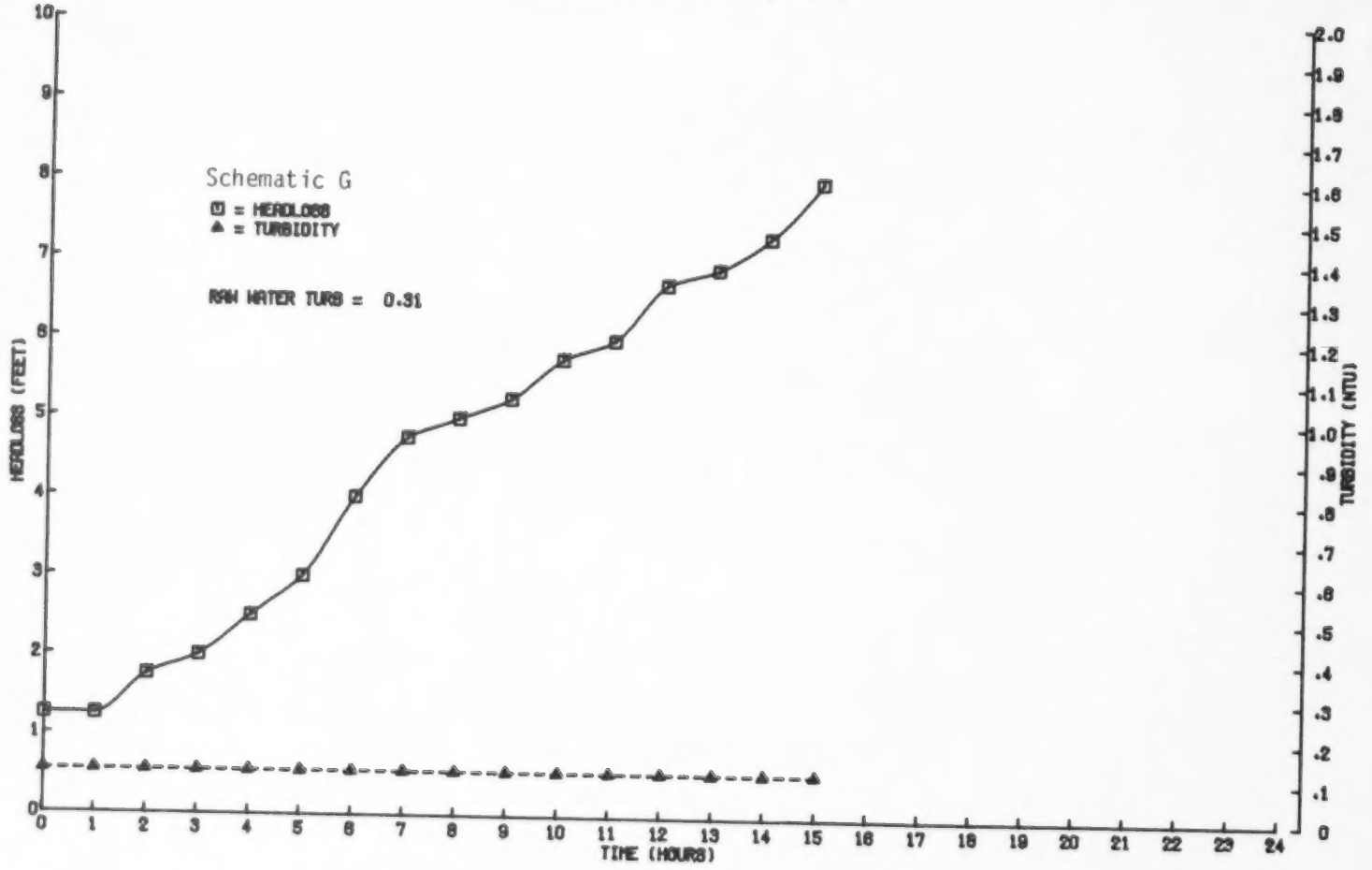
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 76



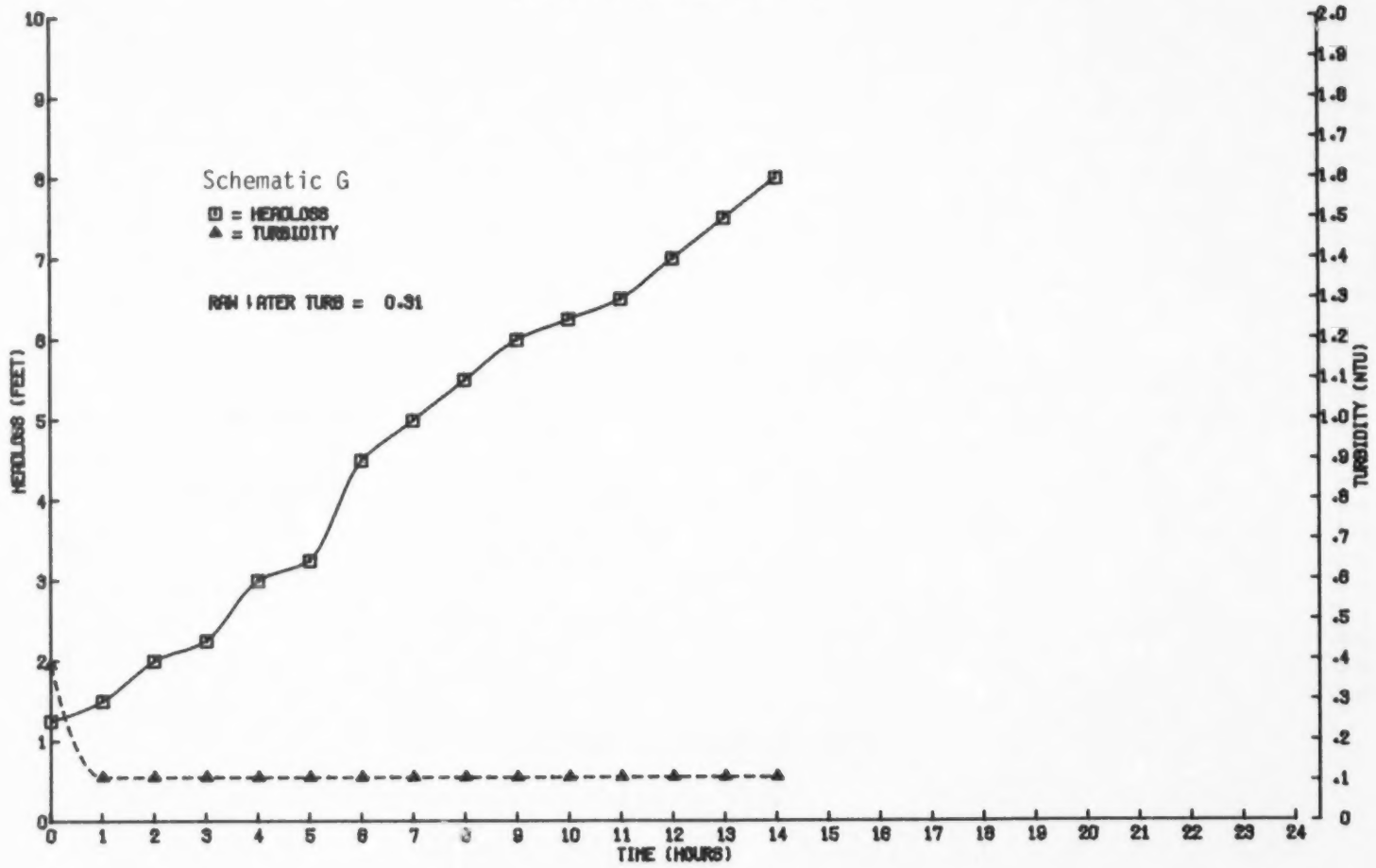
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 77



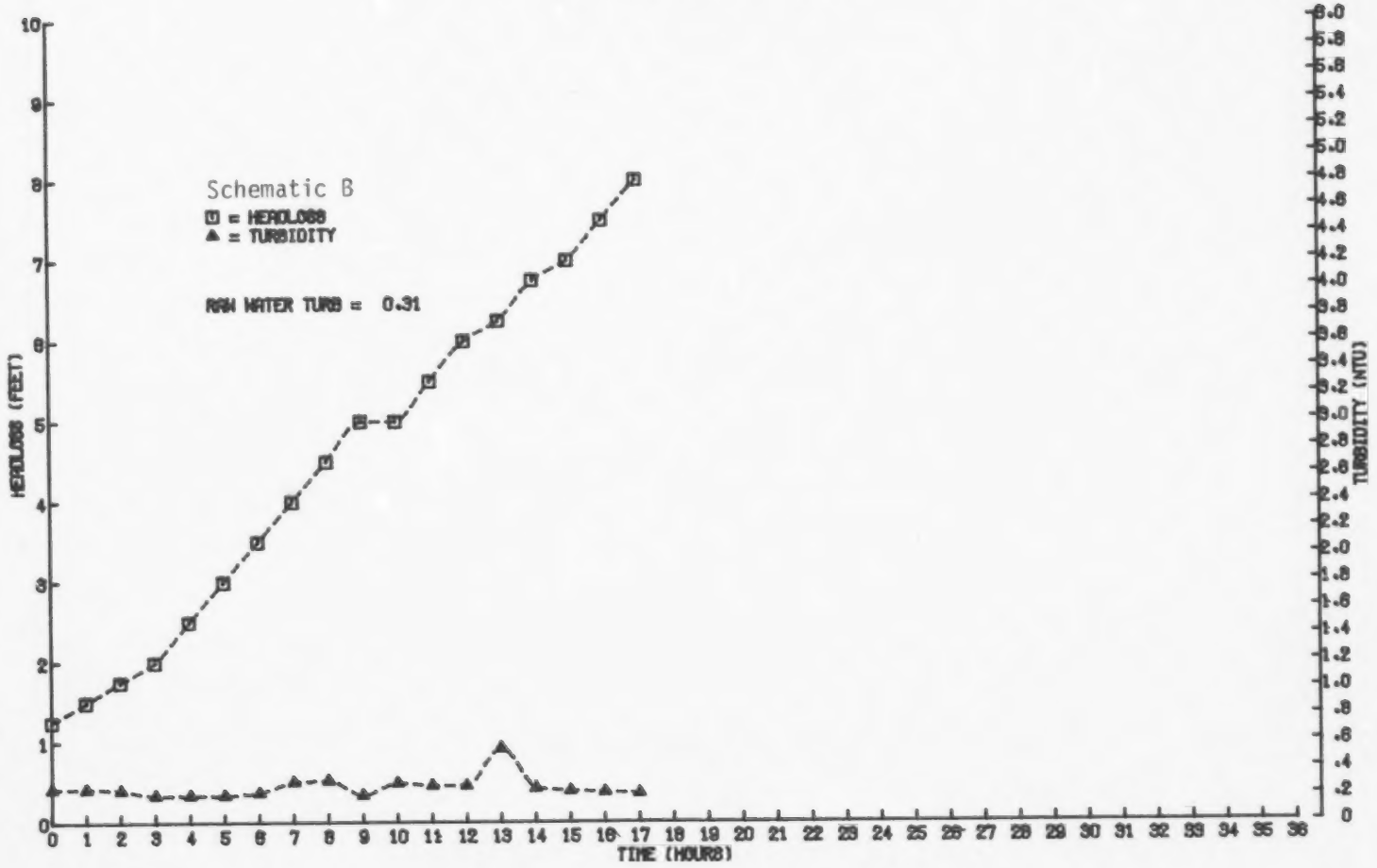
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 78



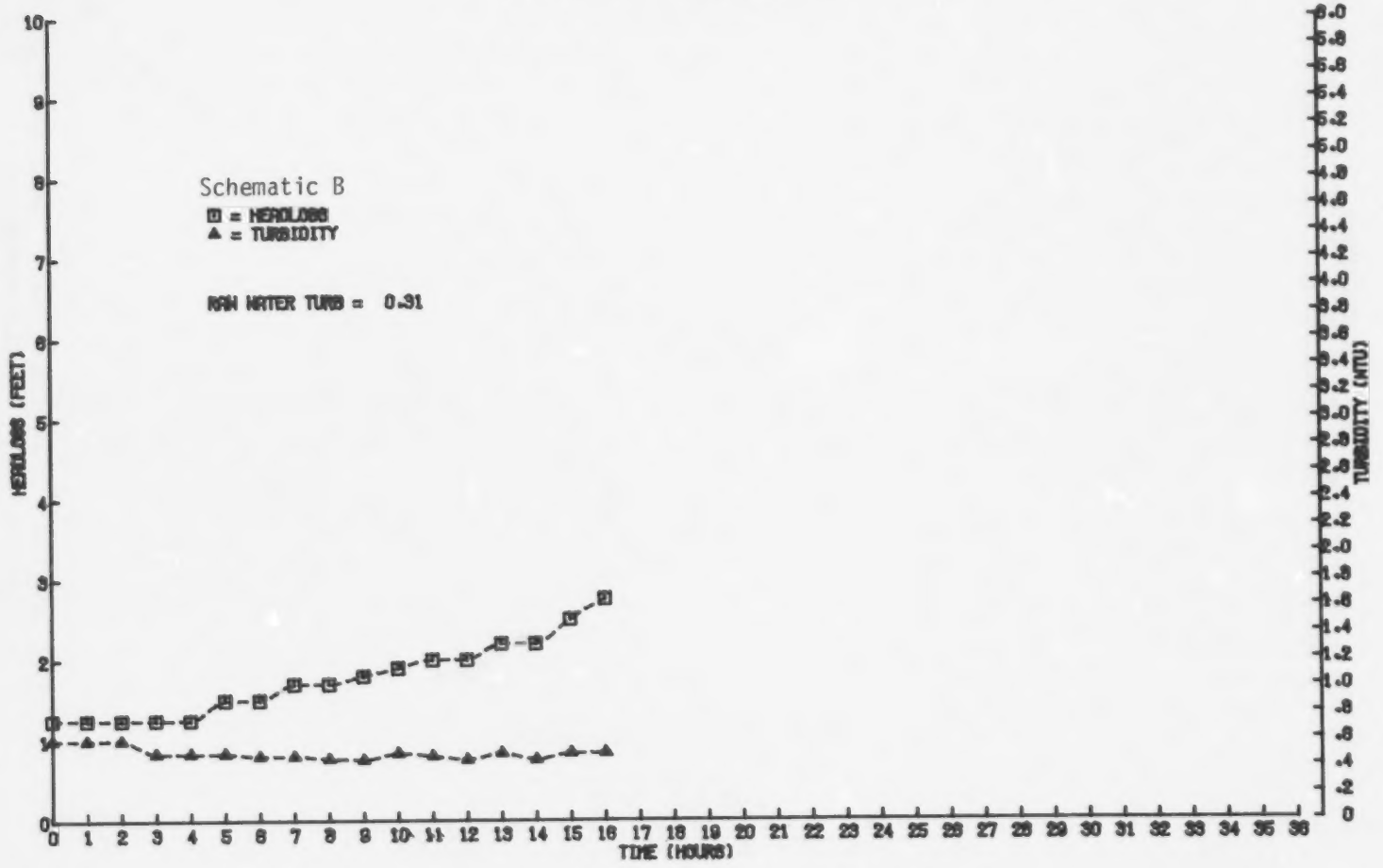
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 79



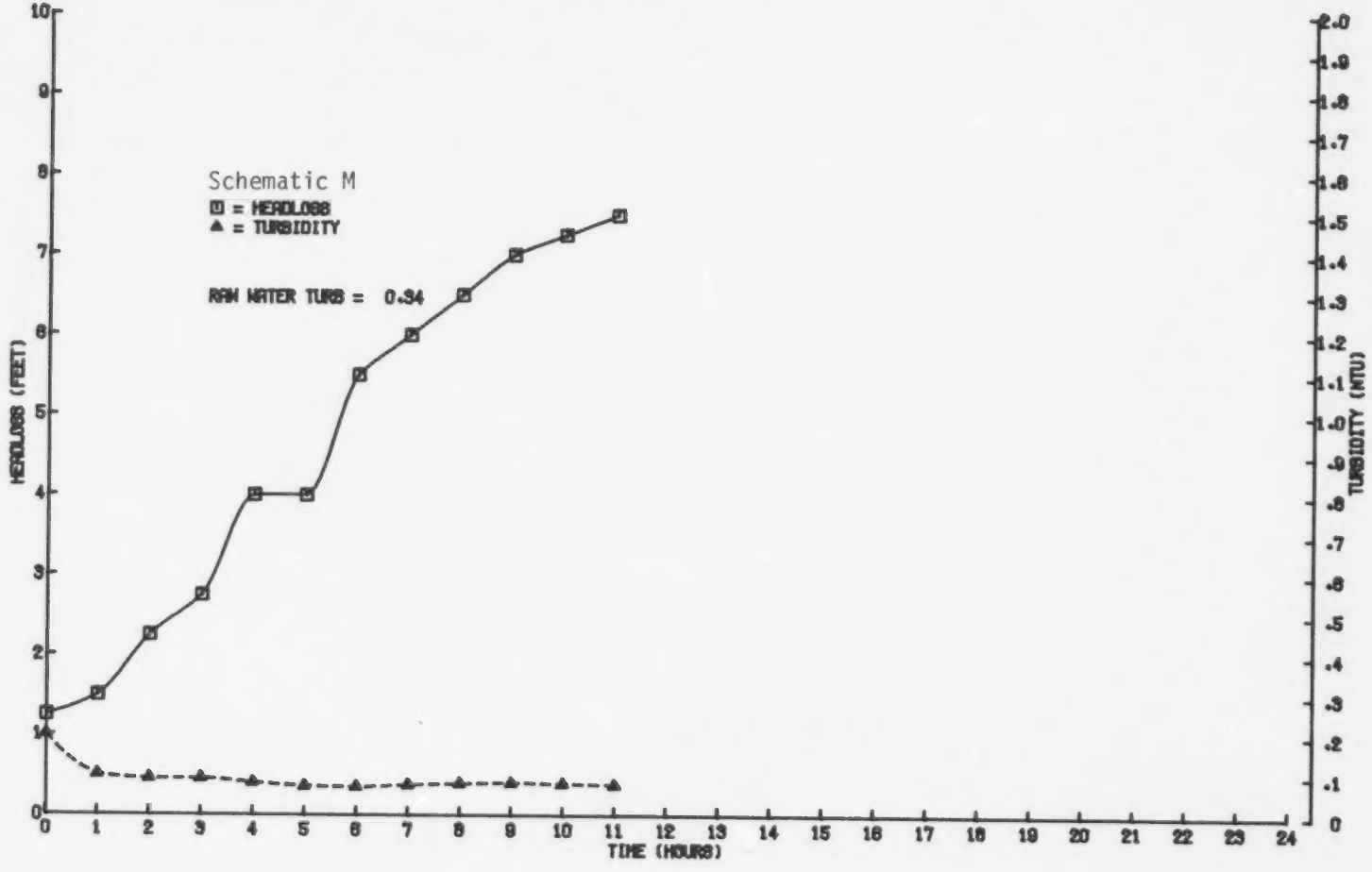
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 80



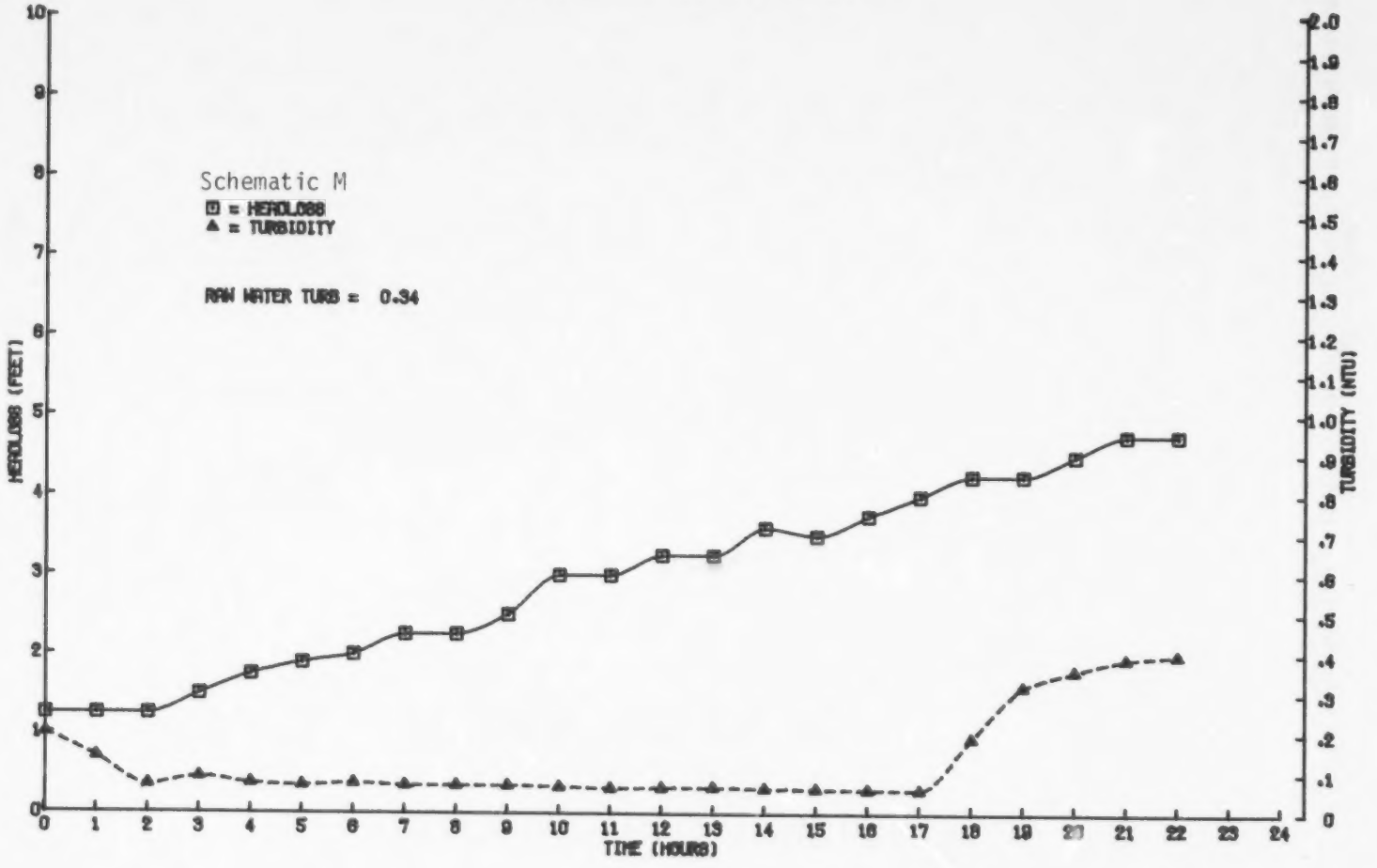
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 80M



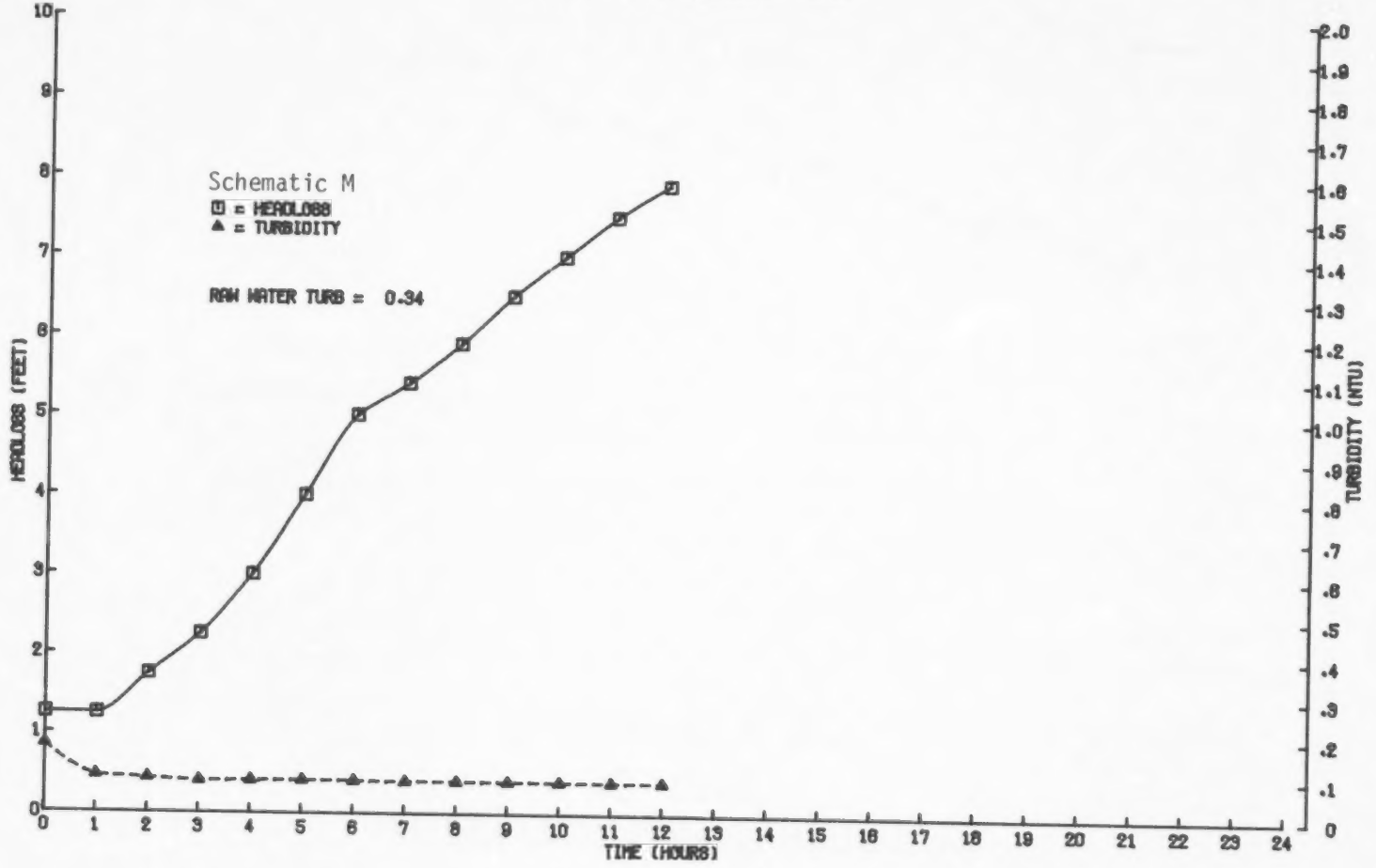
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 81



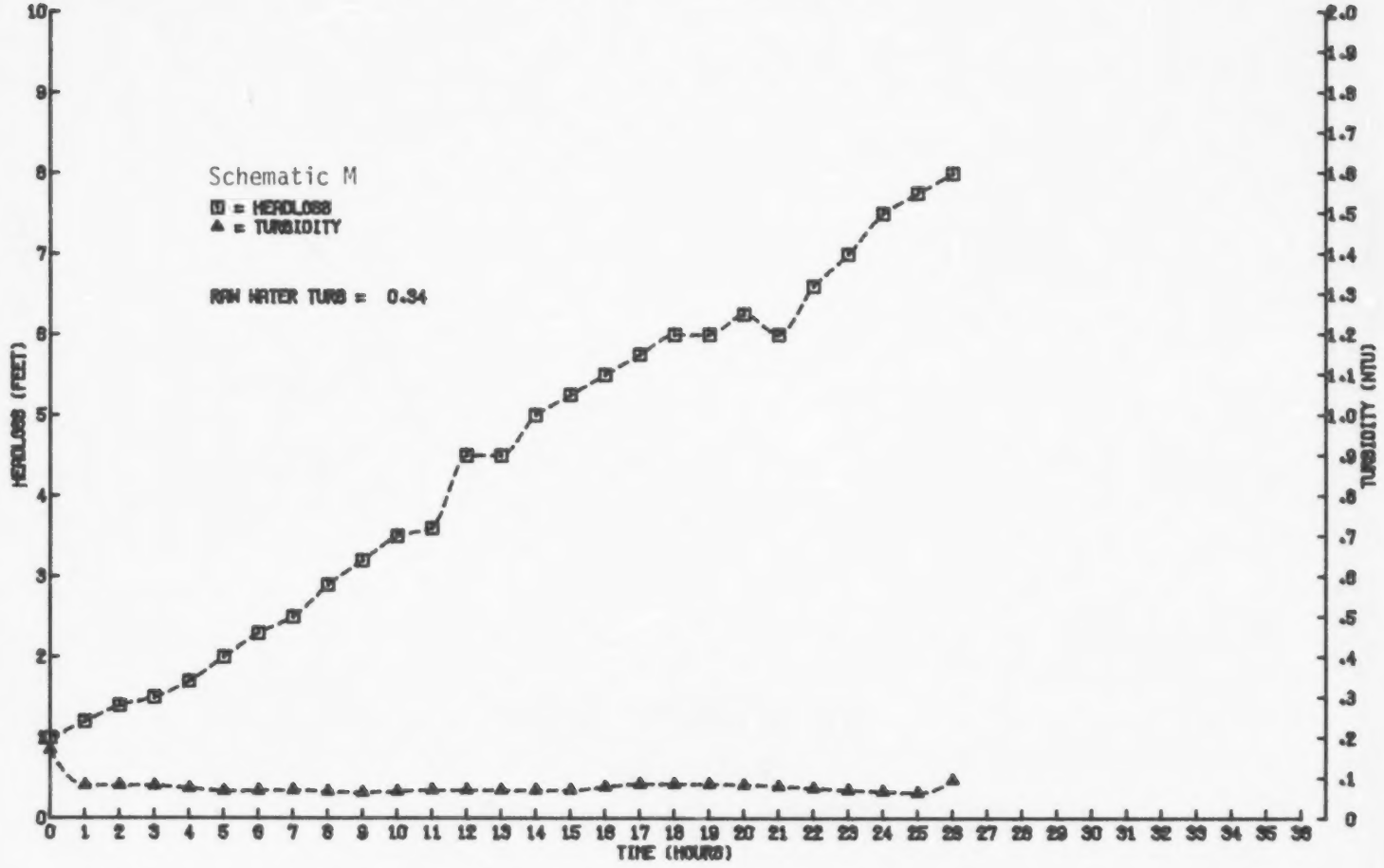
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 81M



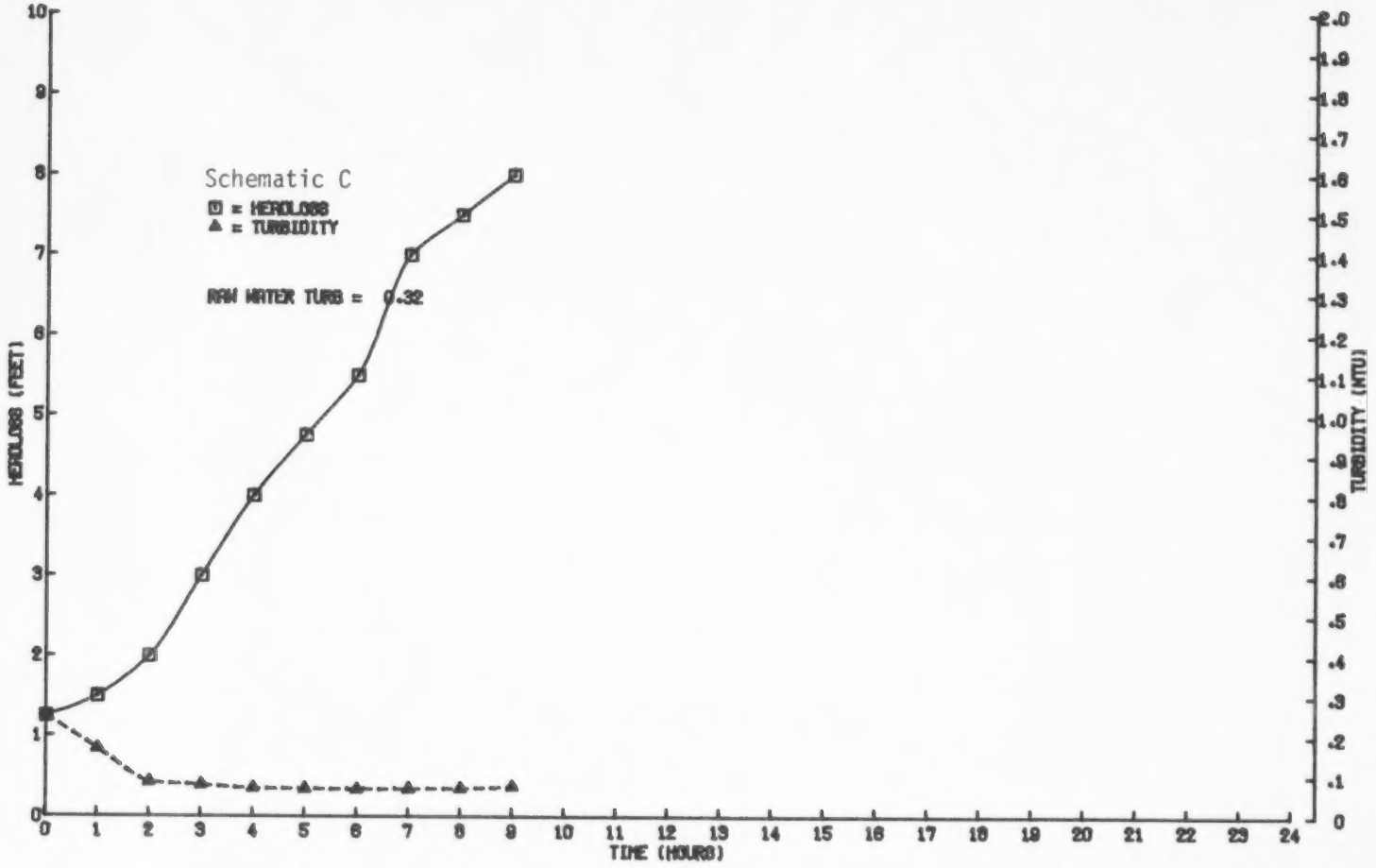
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 82



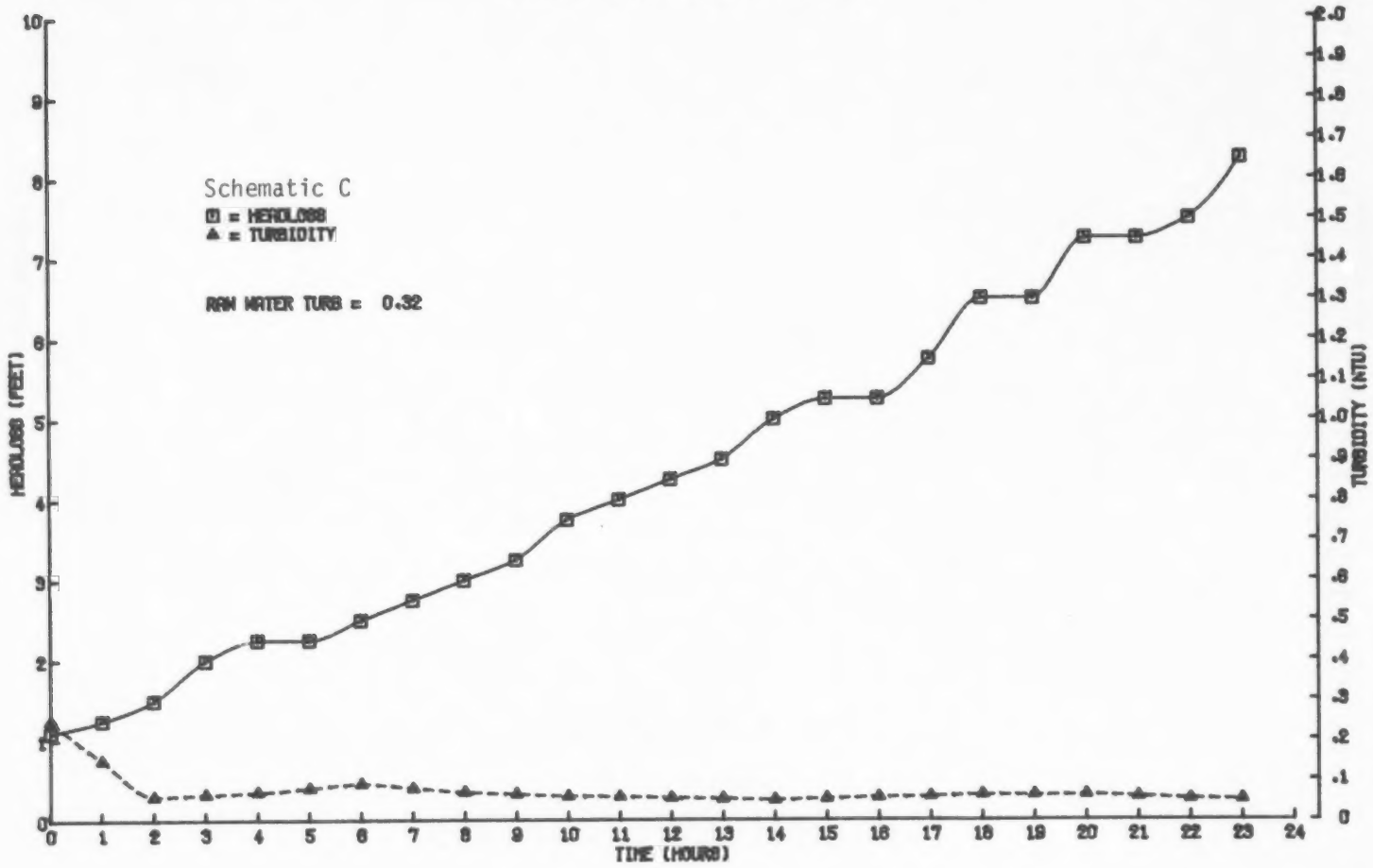
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 82M



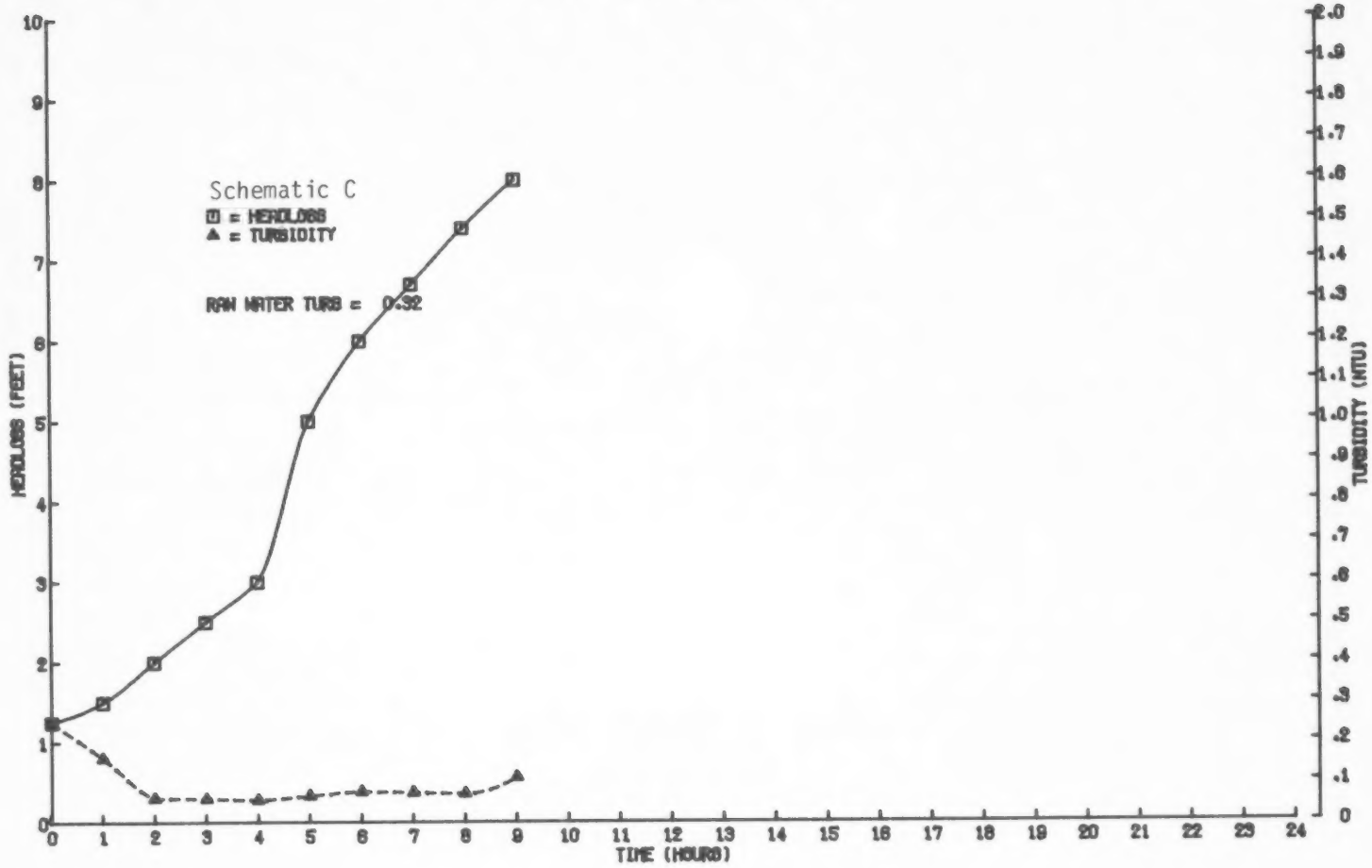
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 83



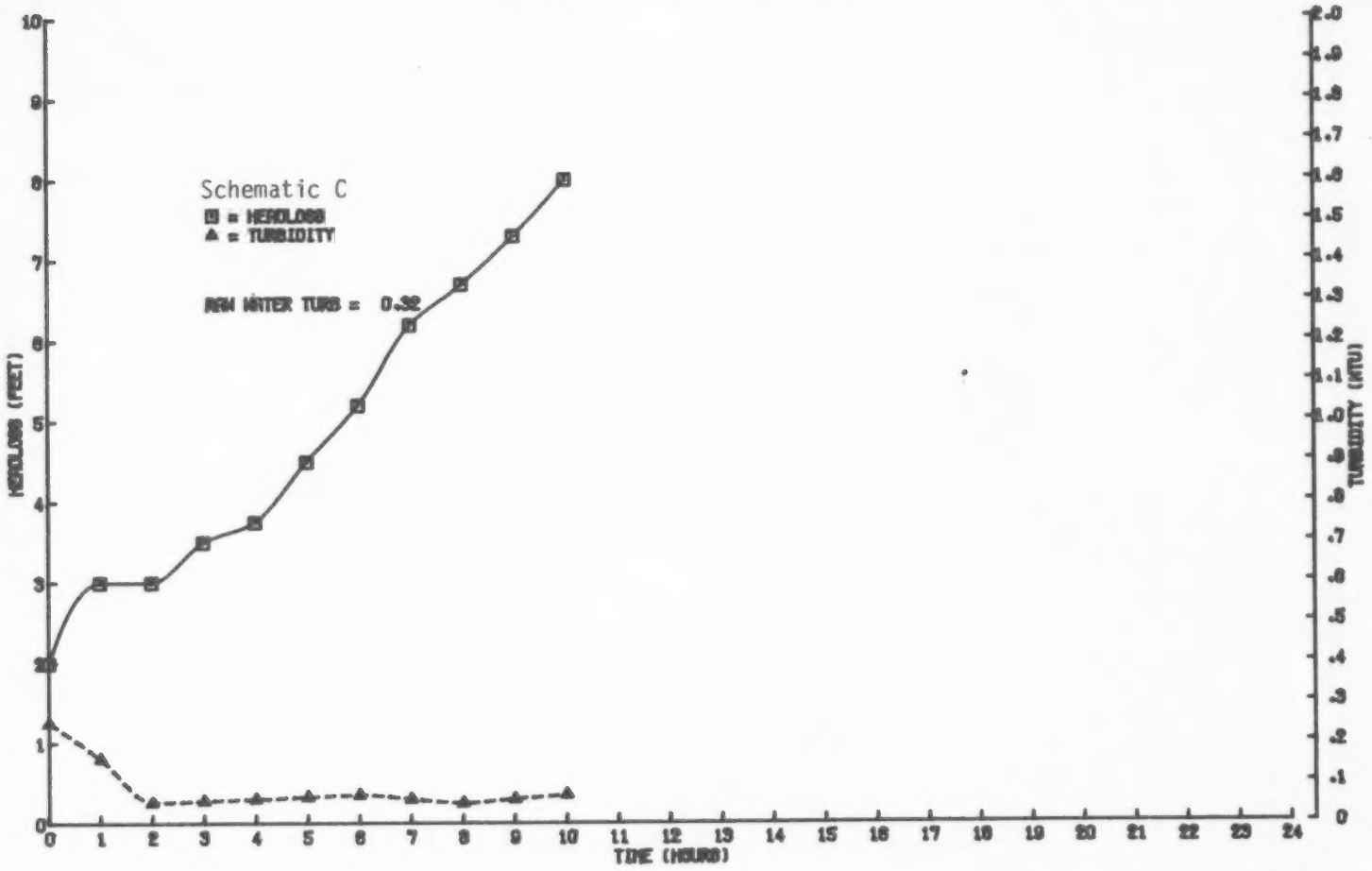
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 83M



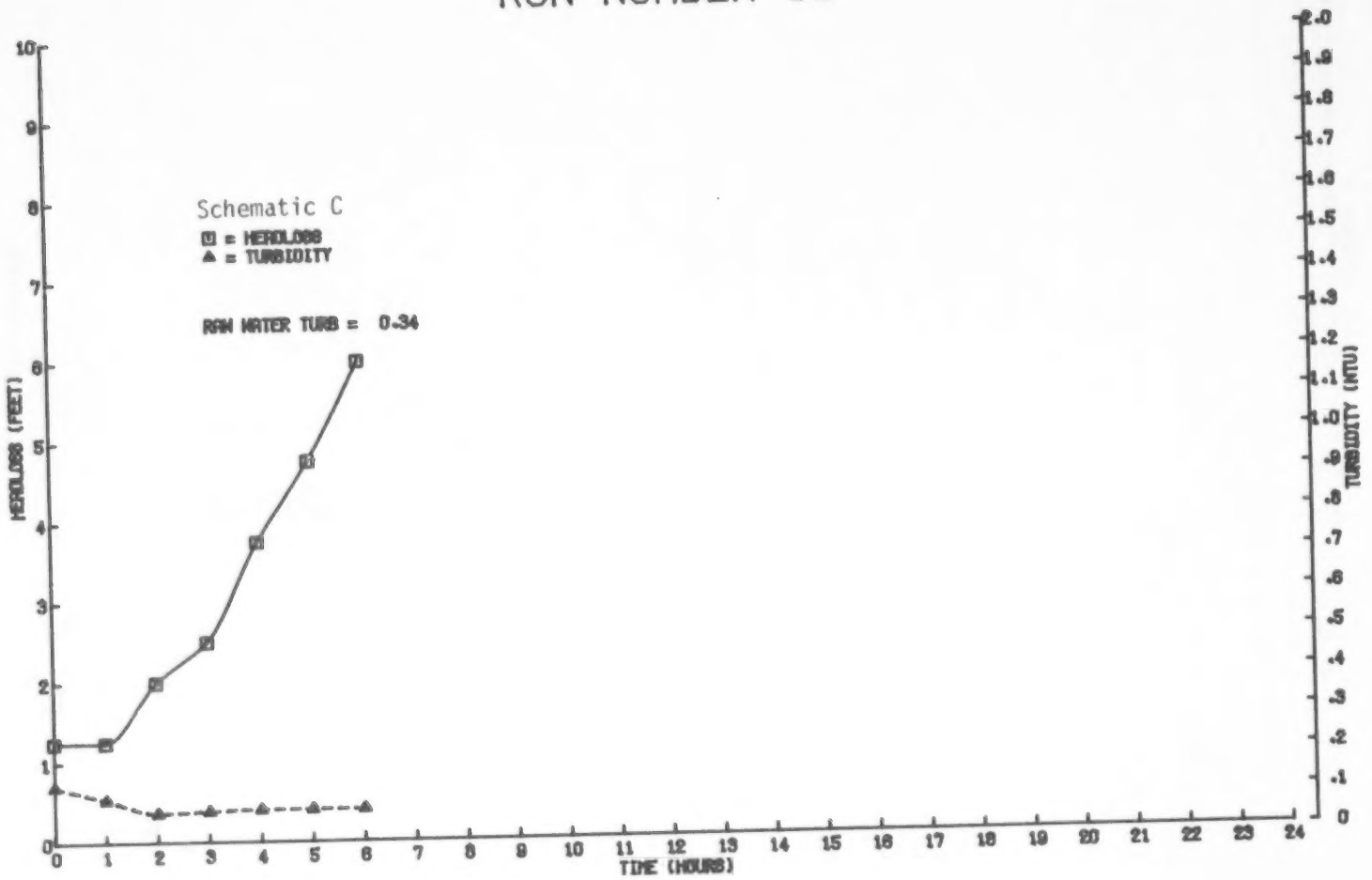
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 84



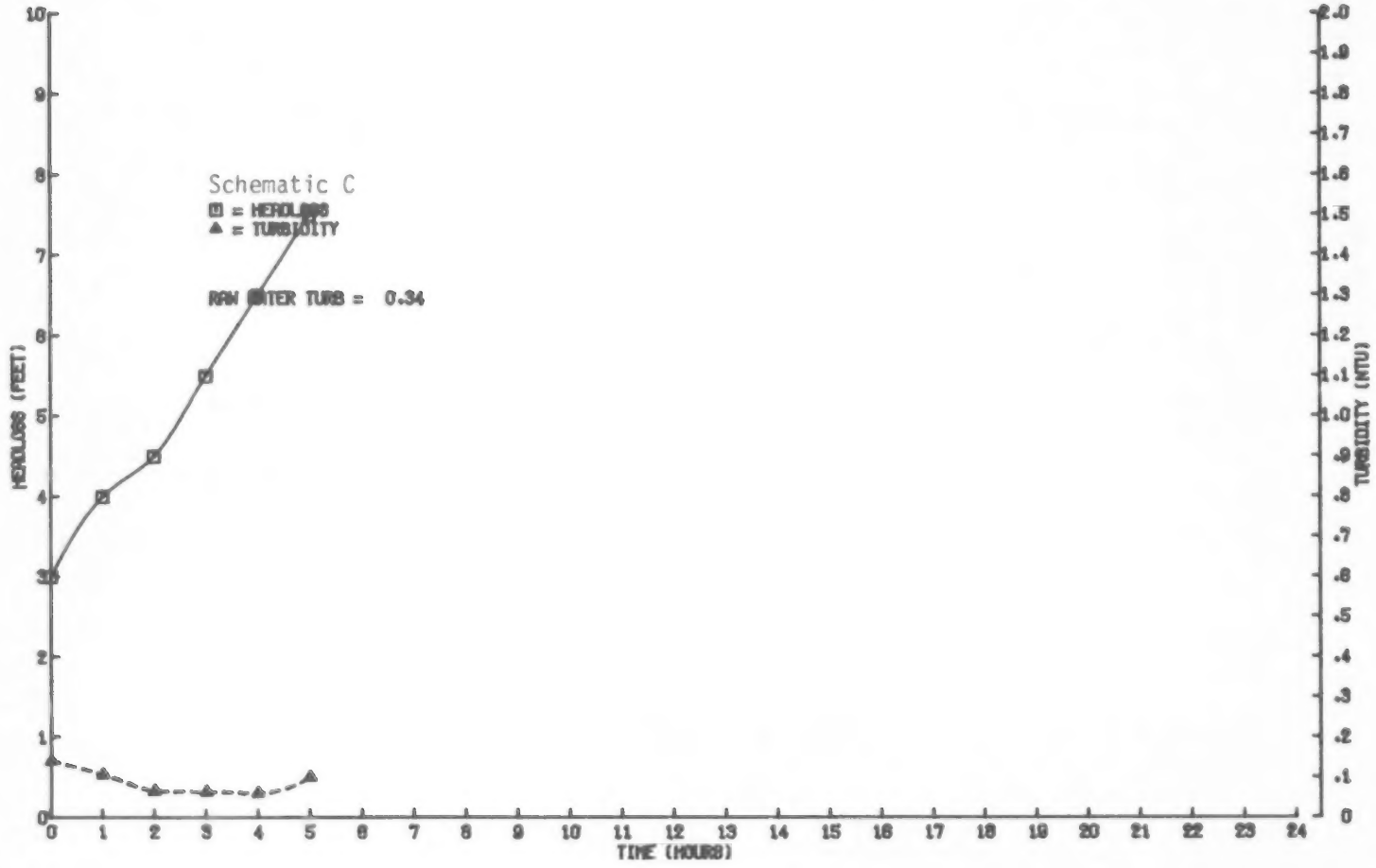
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 84M



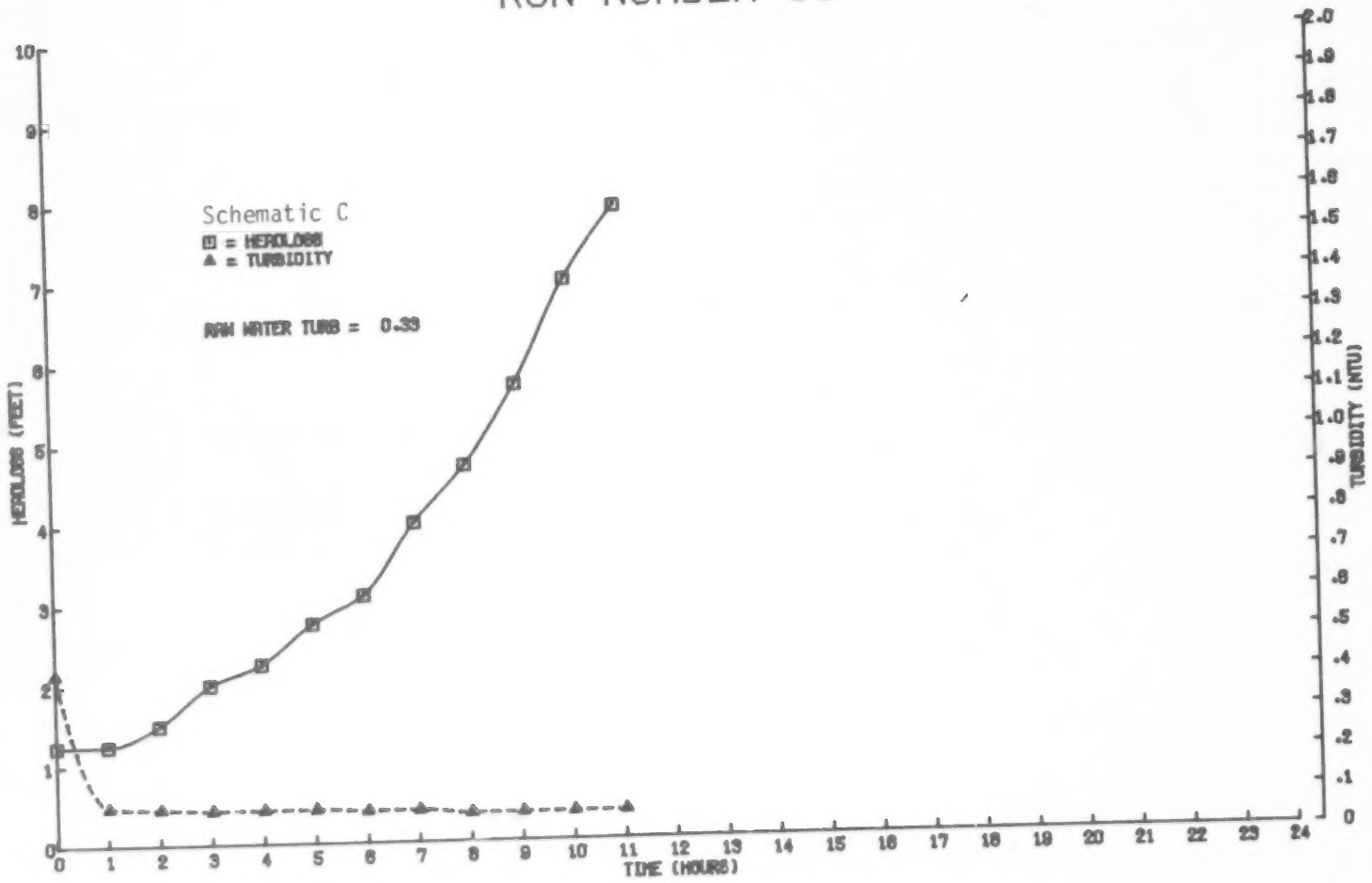
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 85



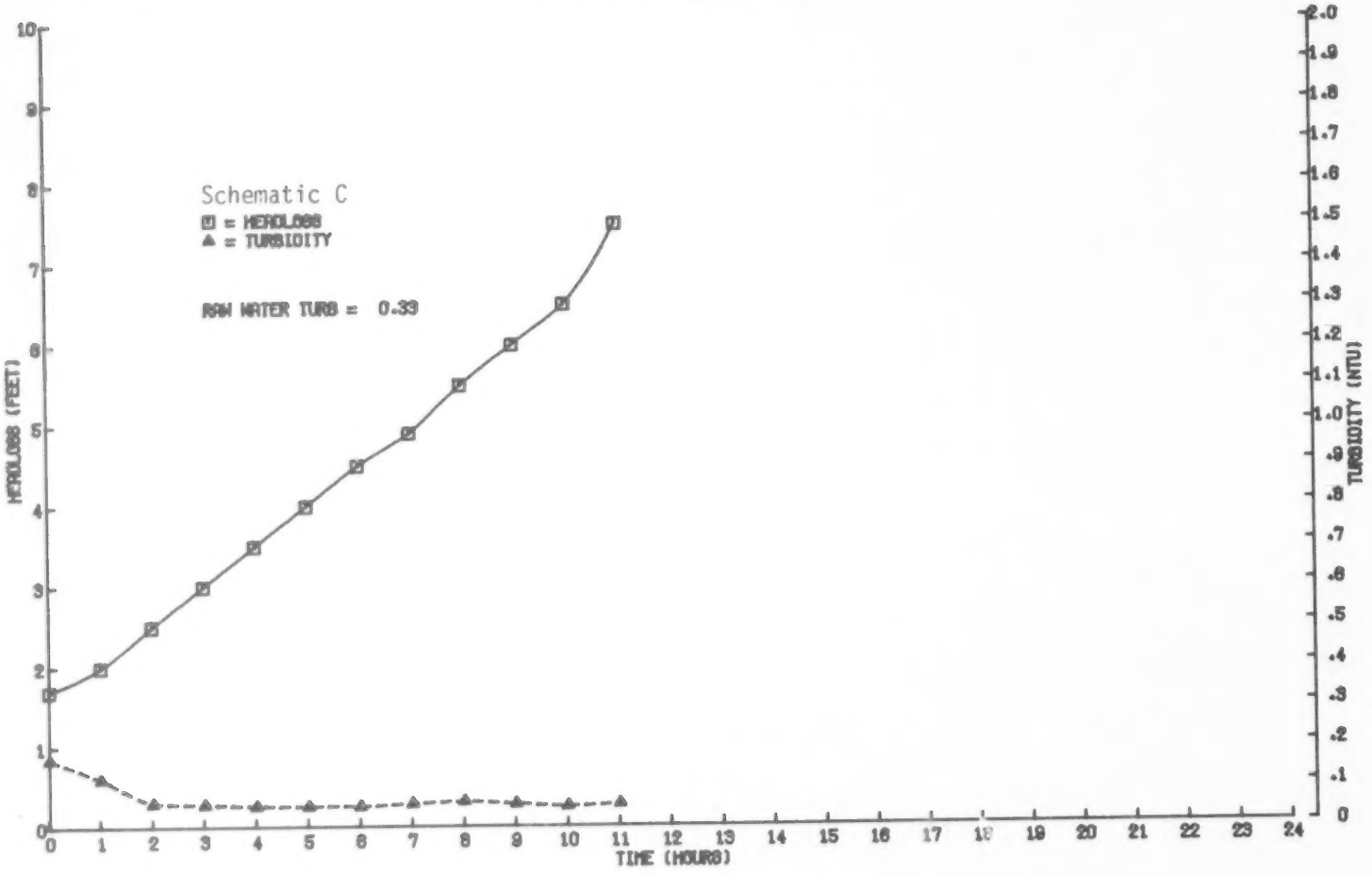
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 85M



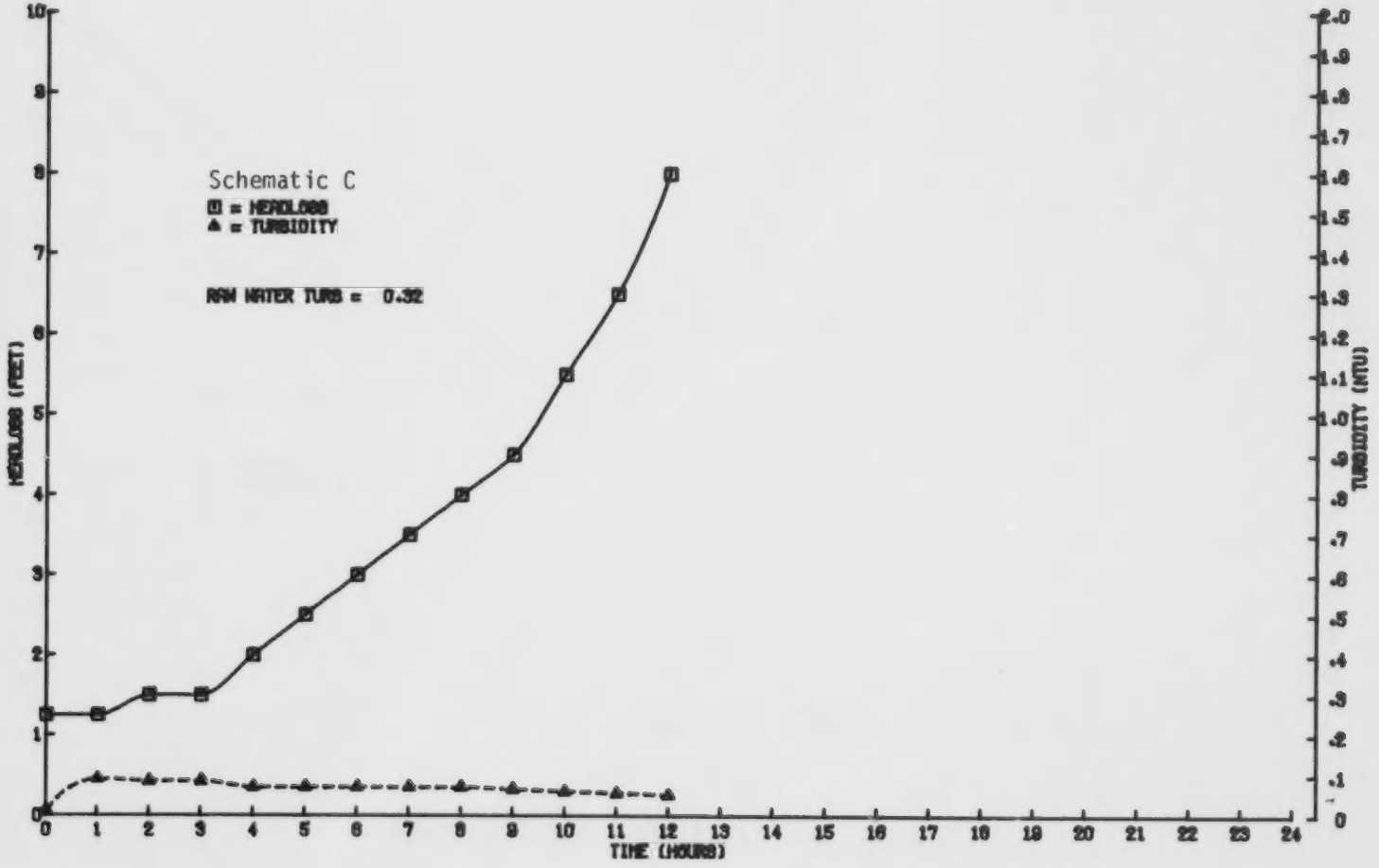
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 86



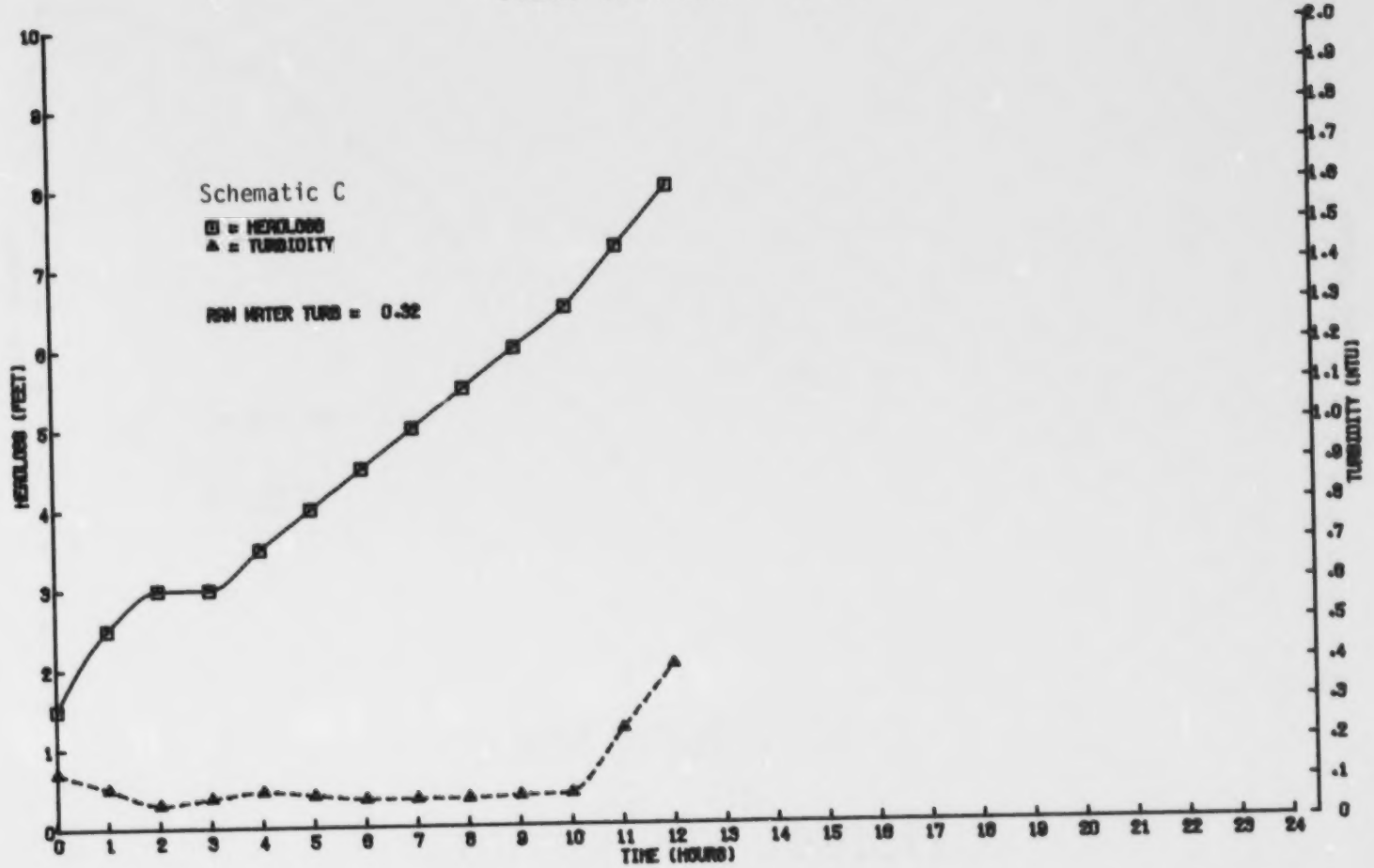
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 86M



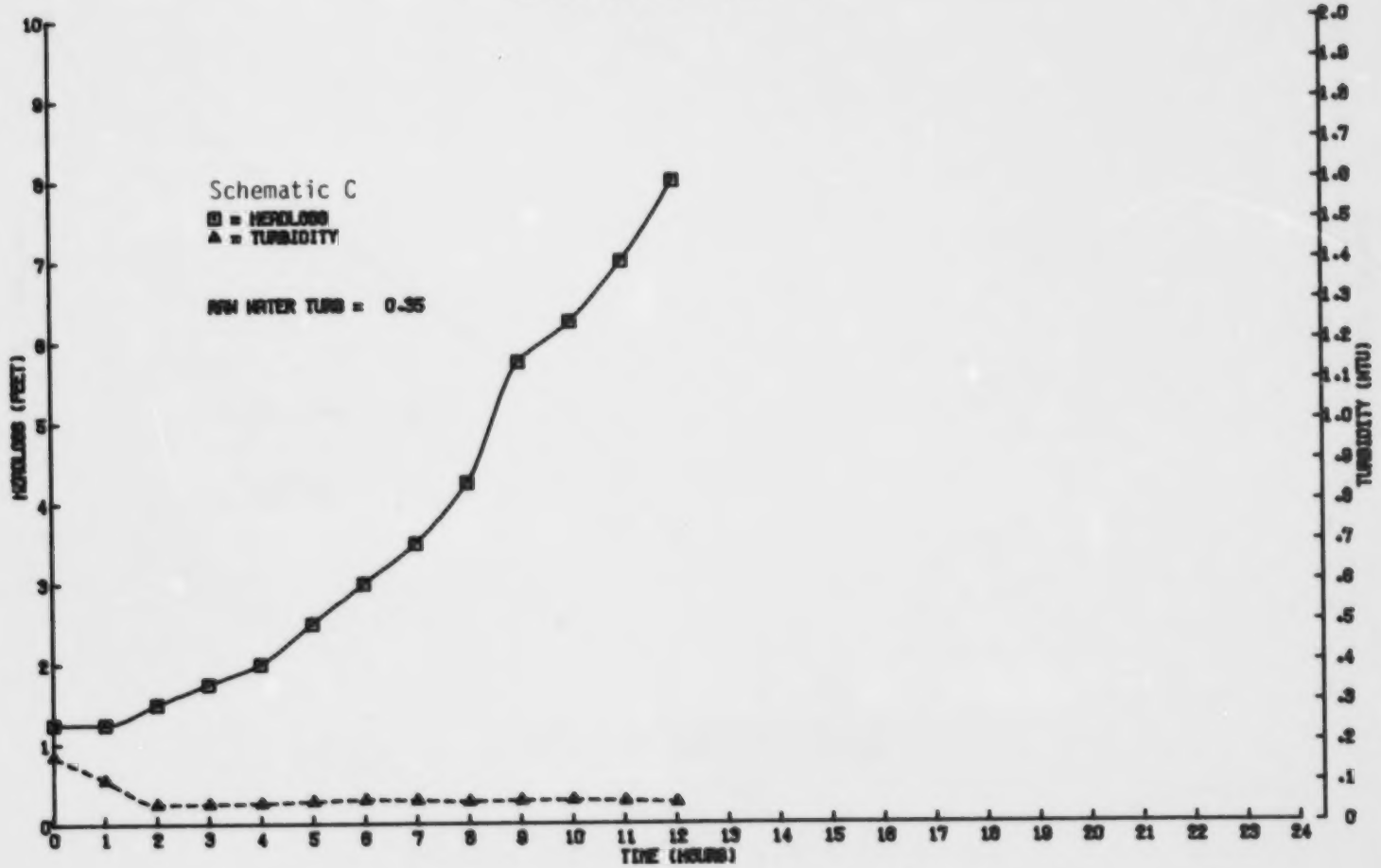
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 87



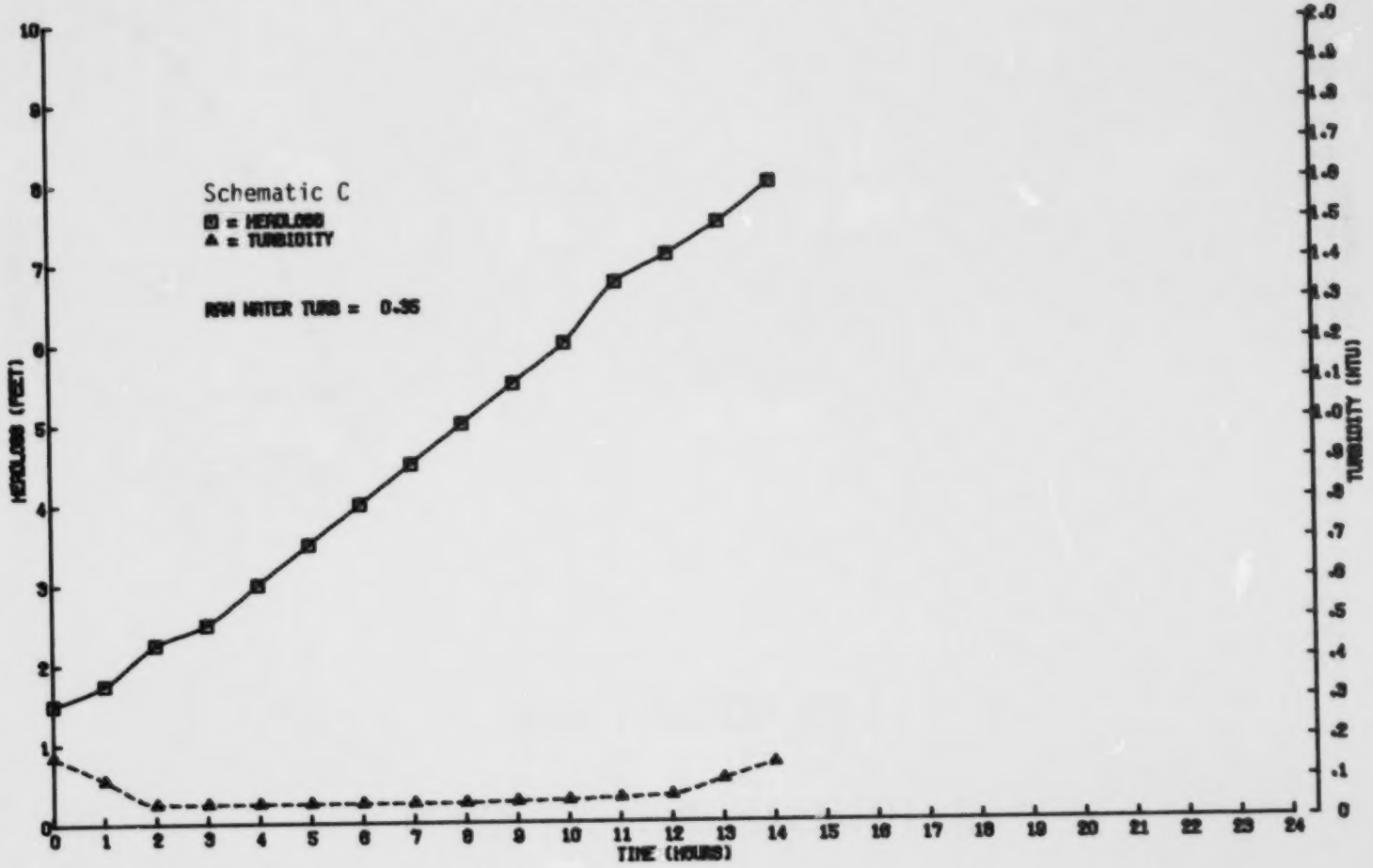
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 87M



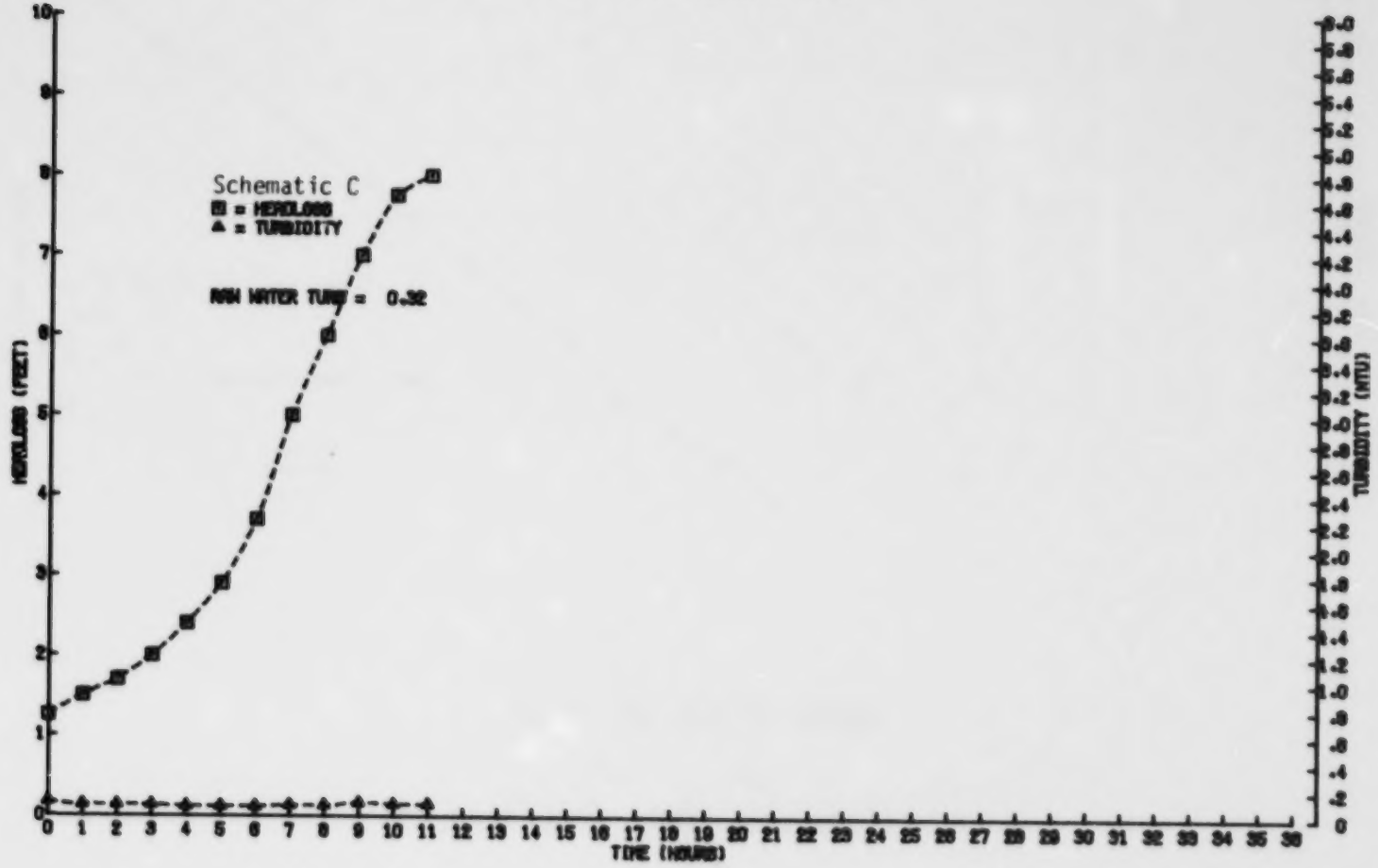
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 88



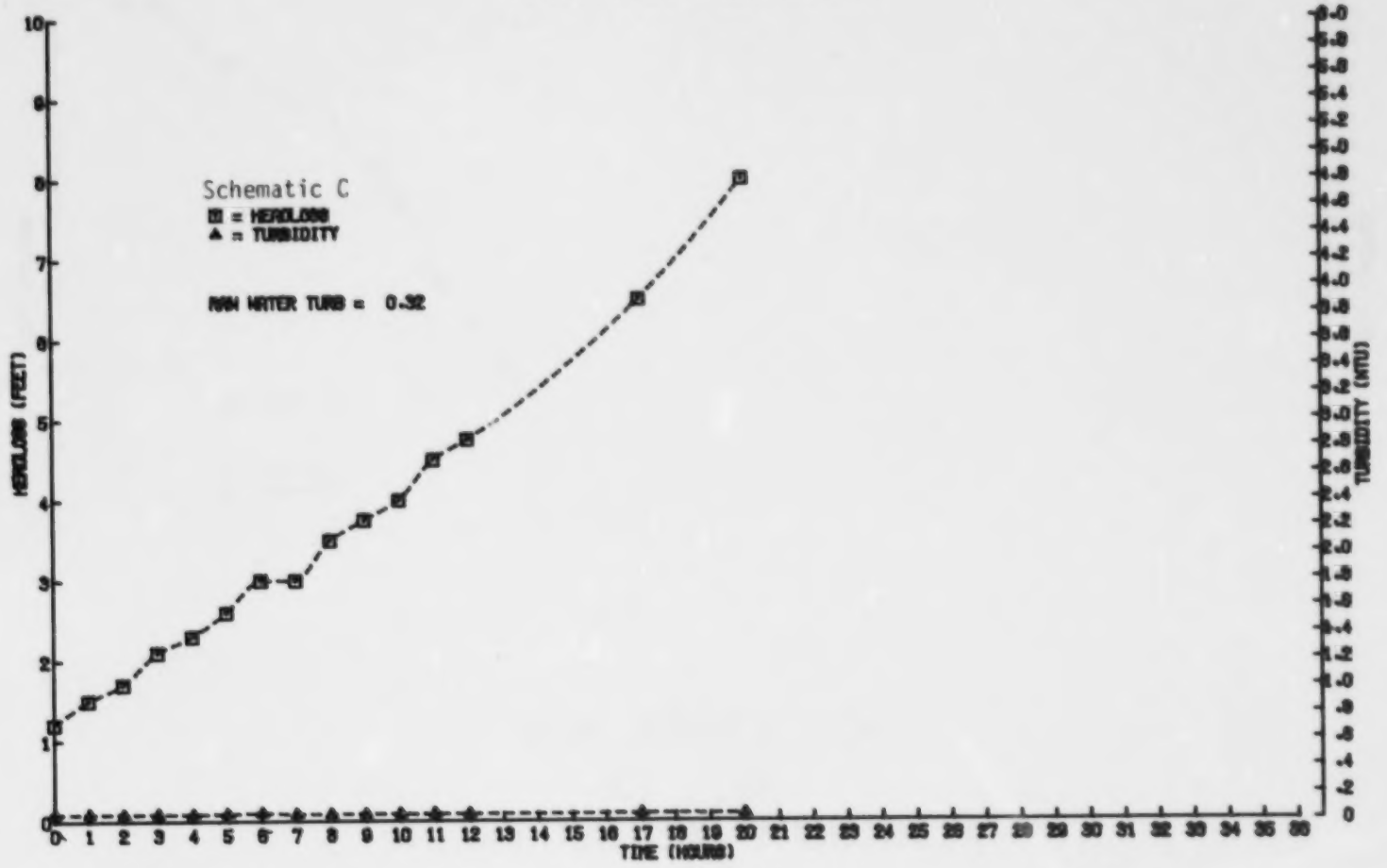
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 88M



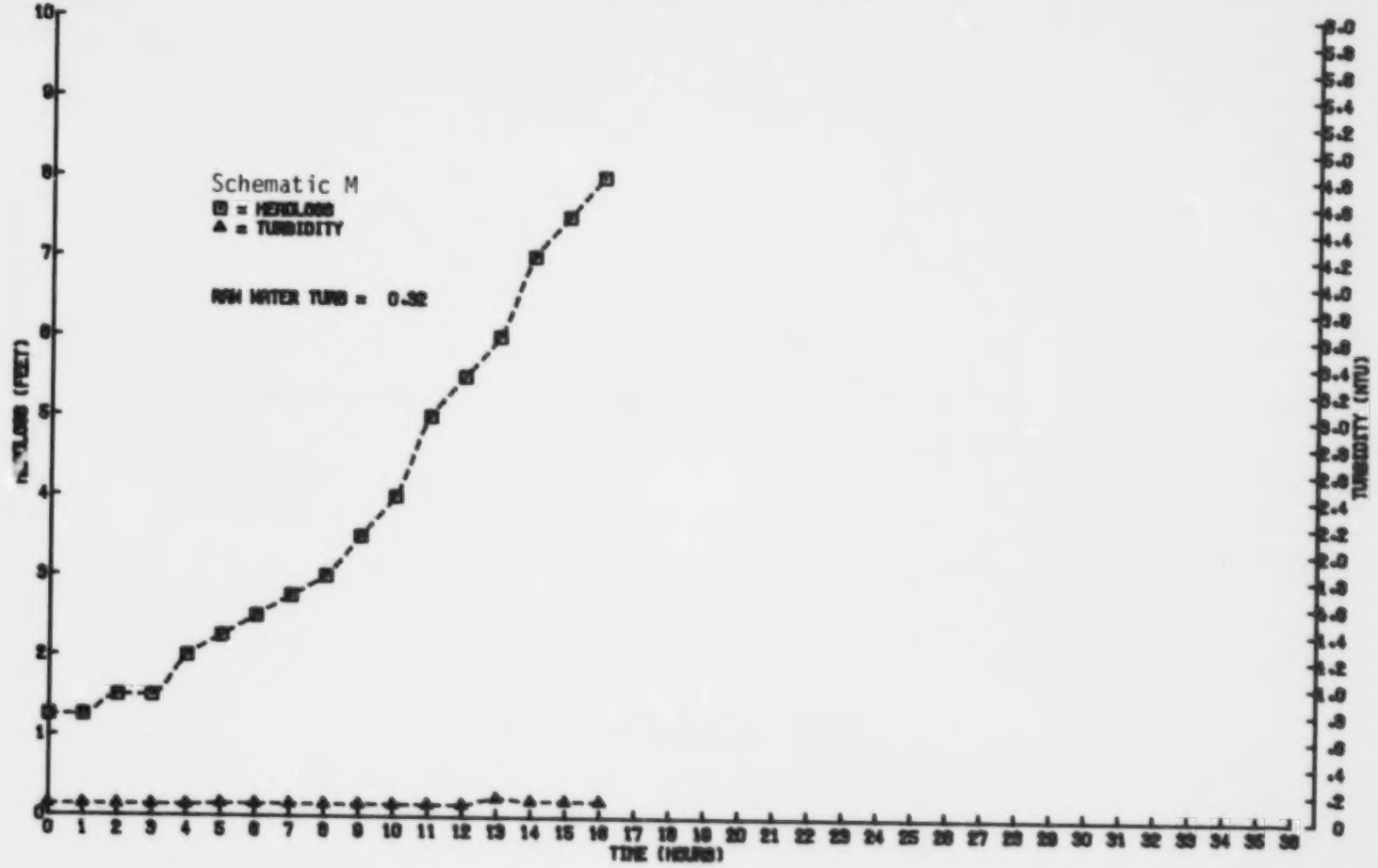
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 89



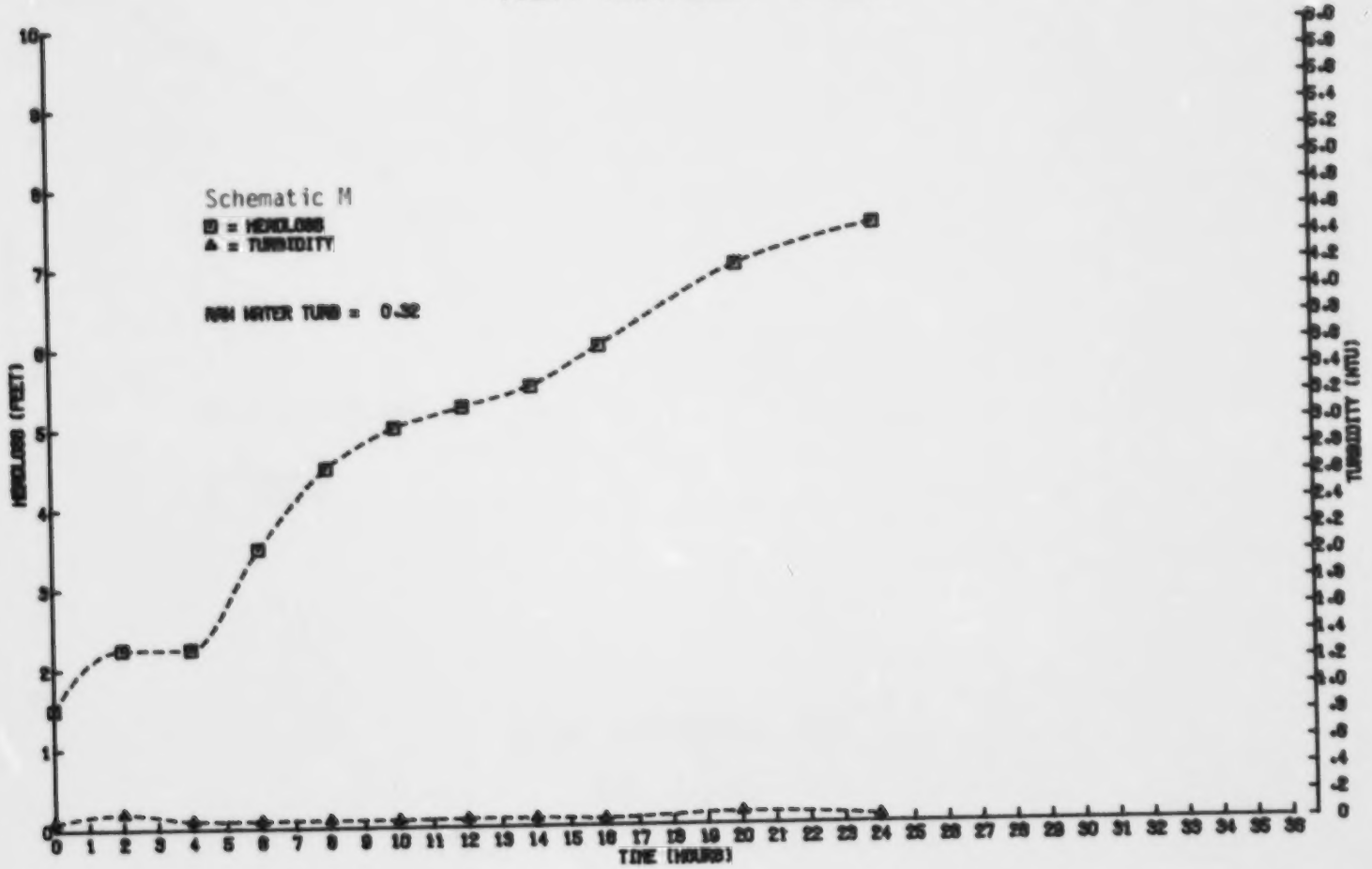
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 89M



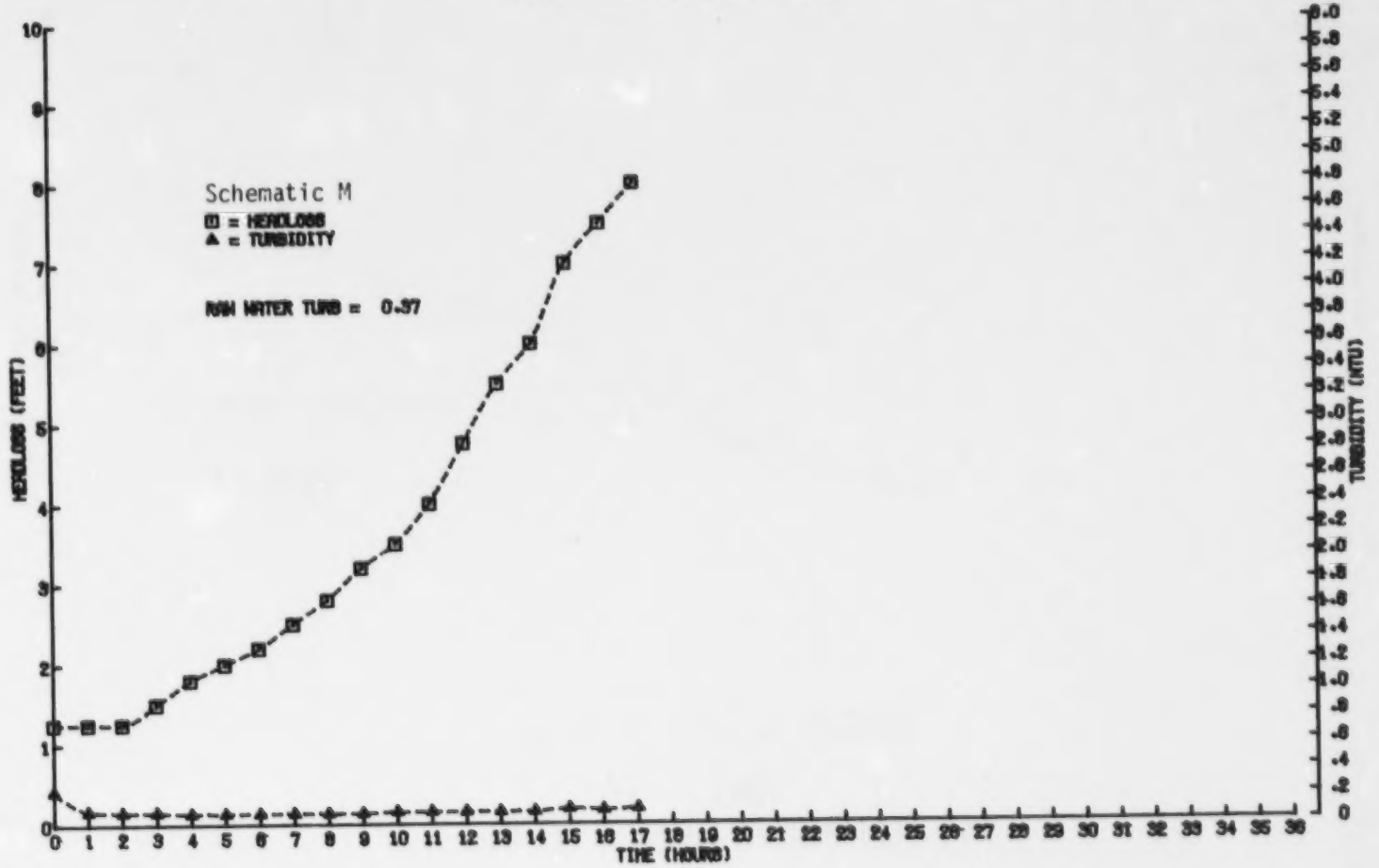
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 89B



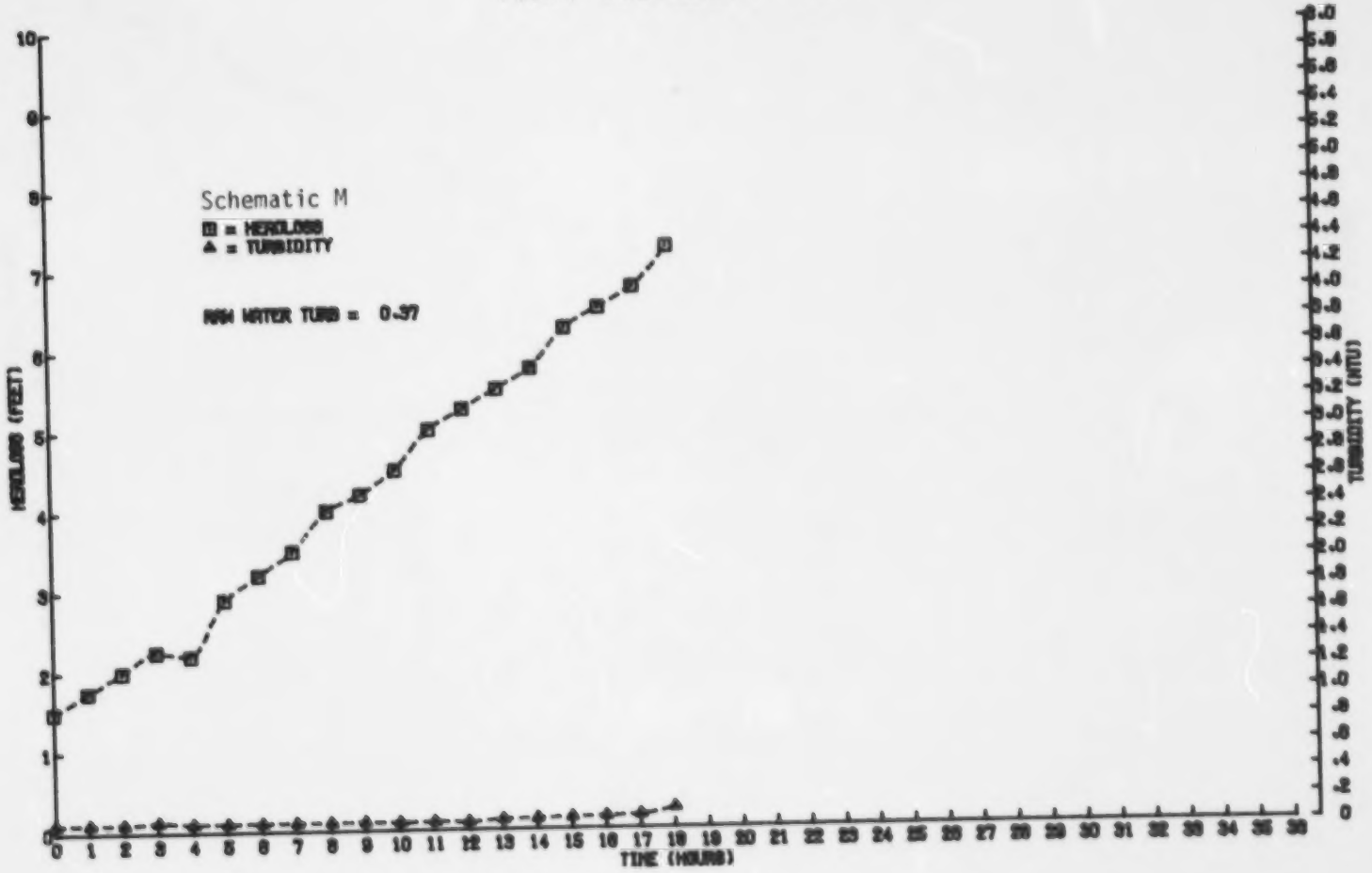
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 89BM



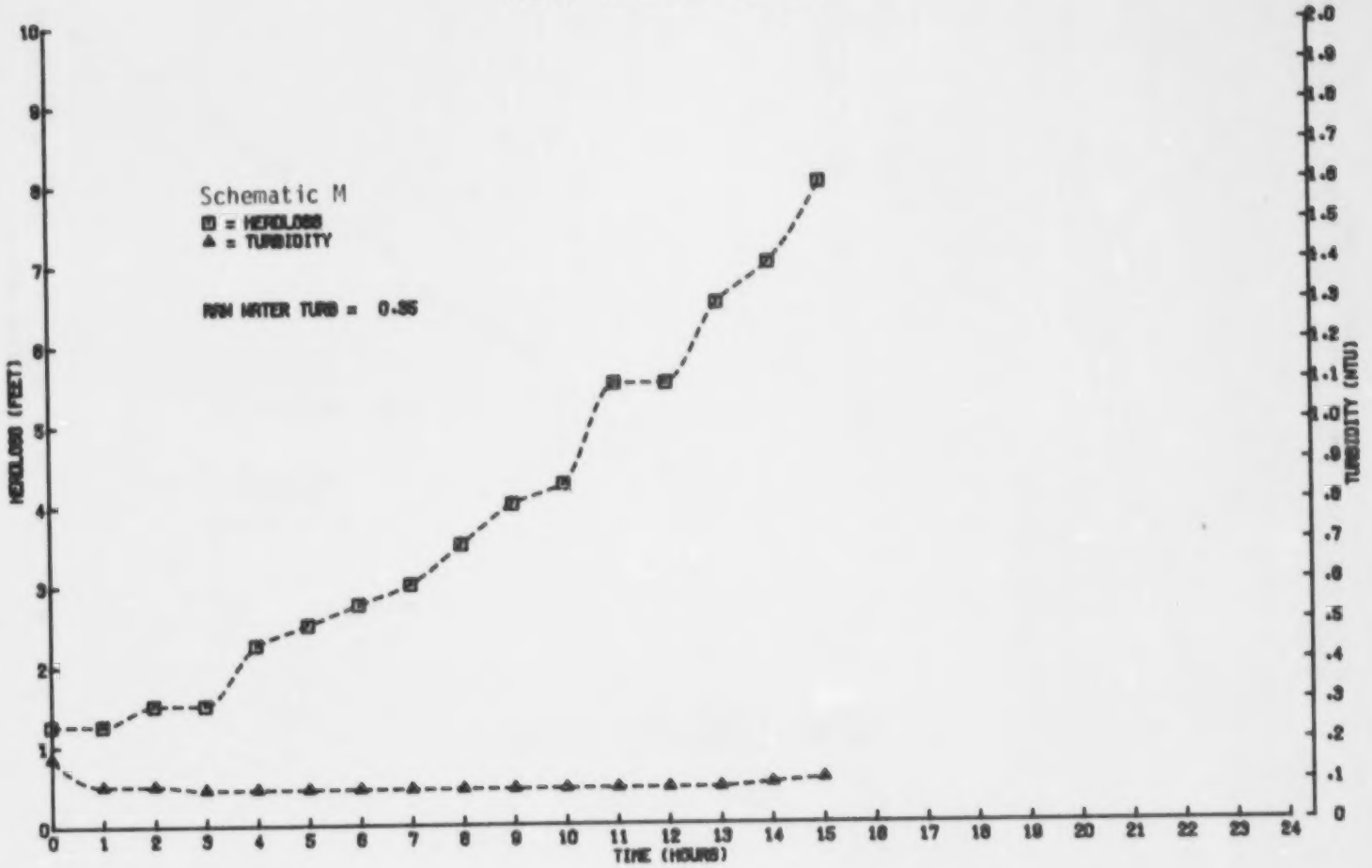
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 90



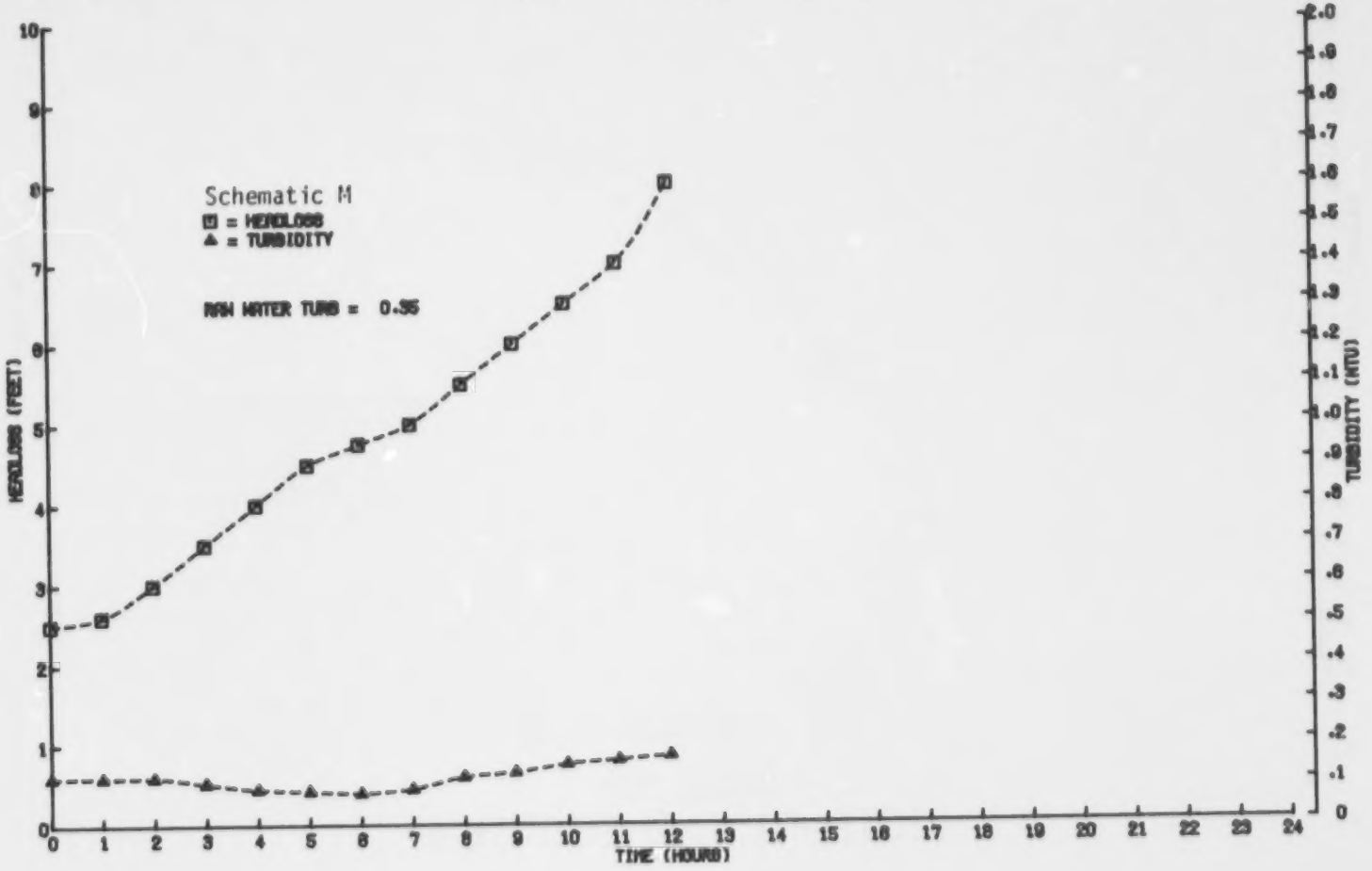
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 90M



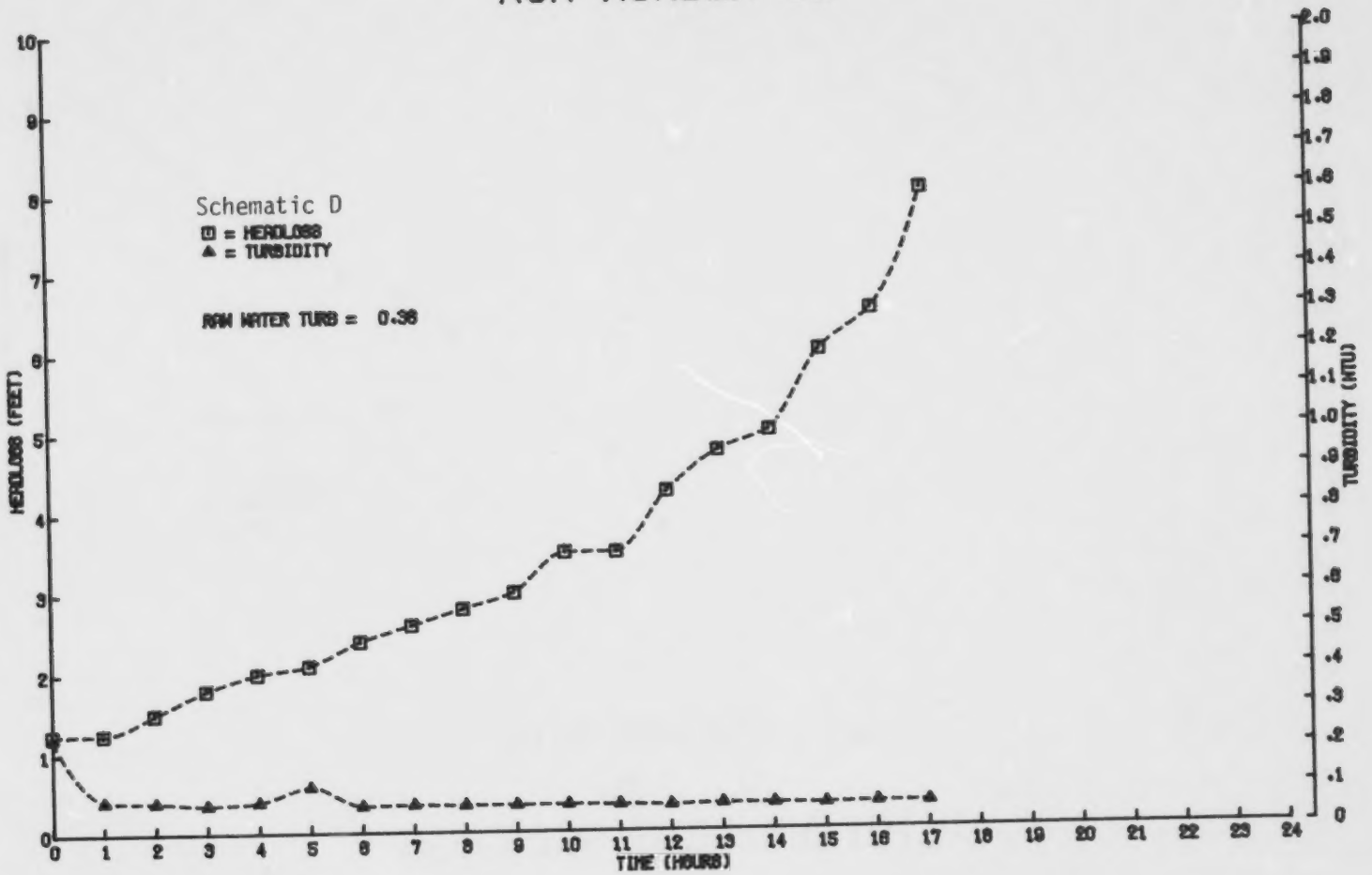
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 91



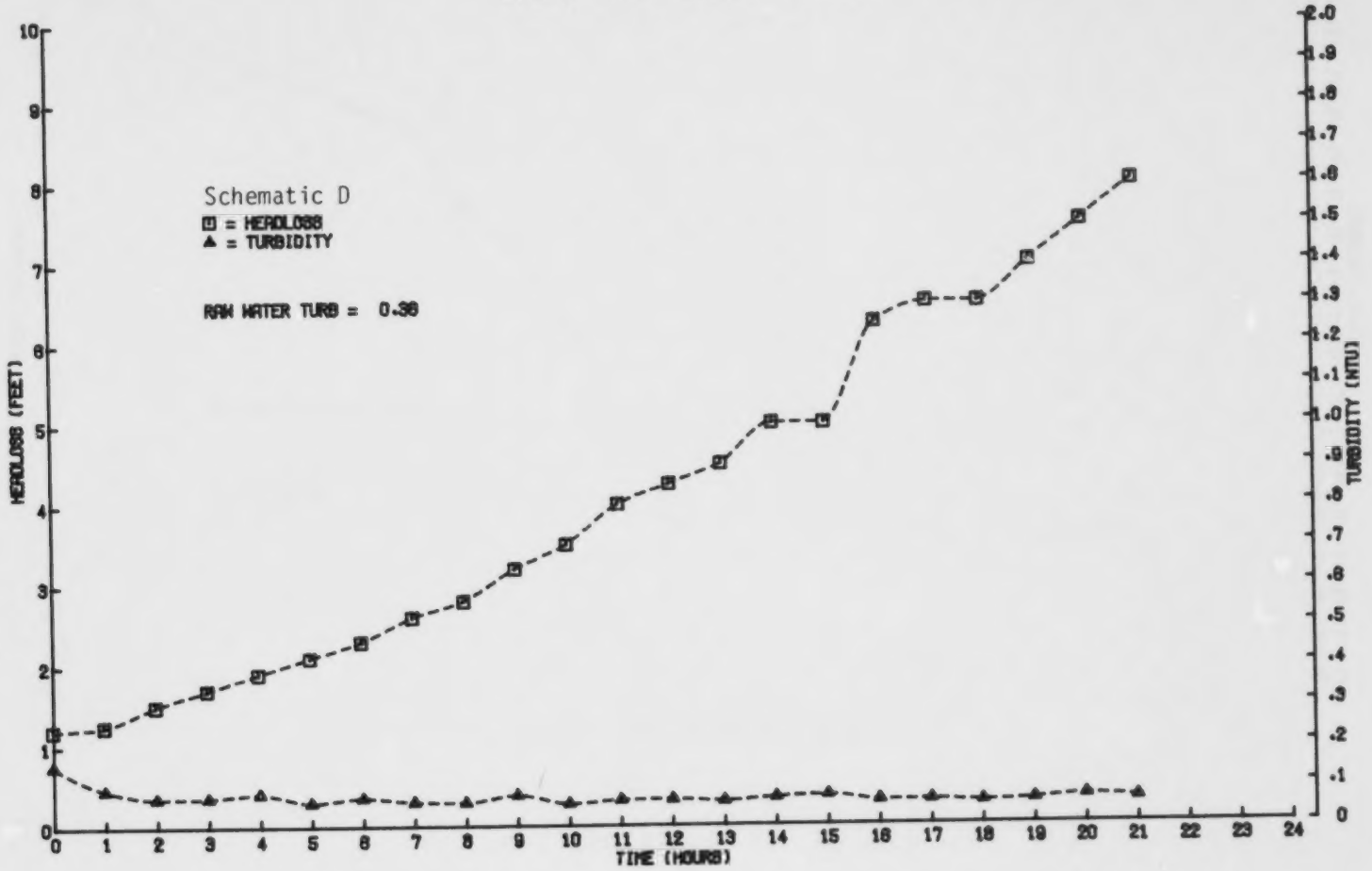
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 91M



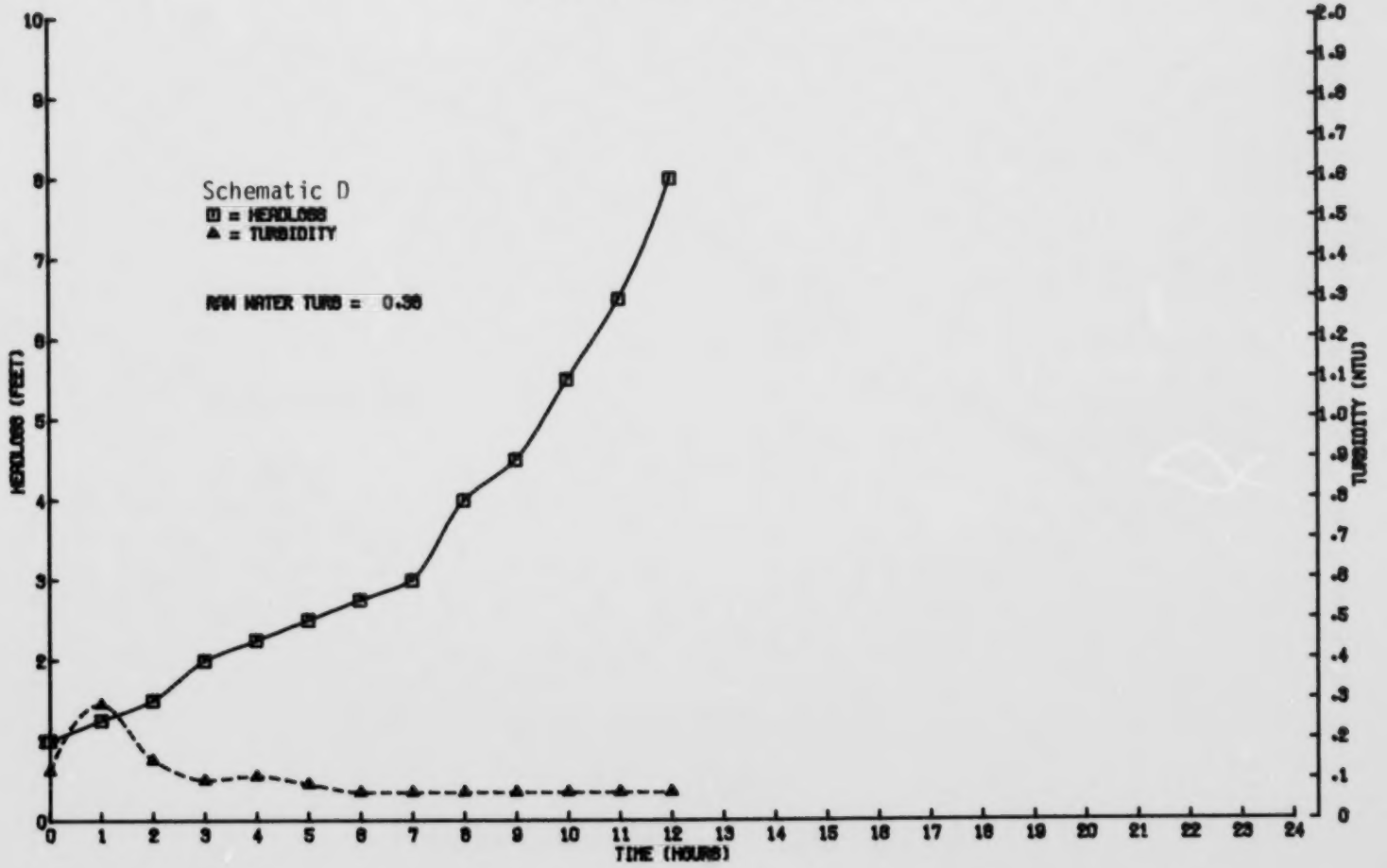
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 92



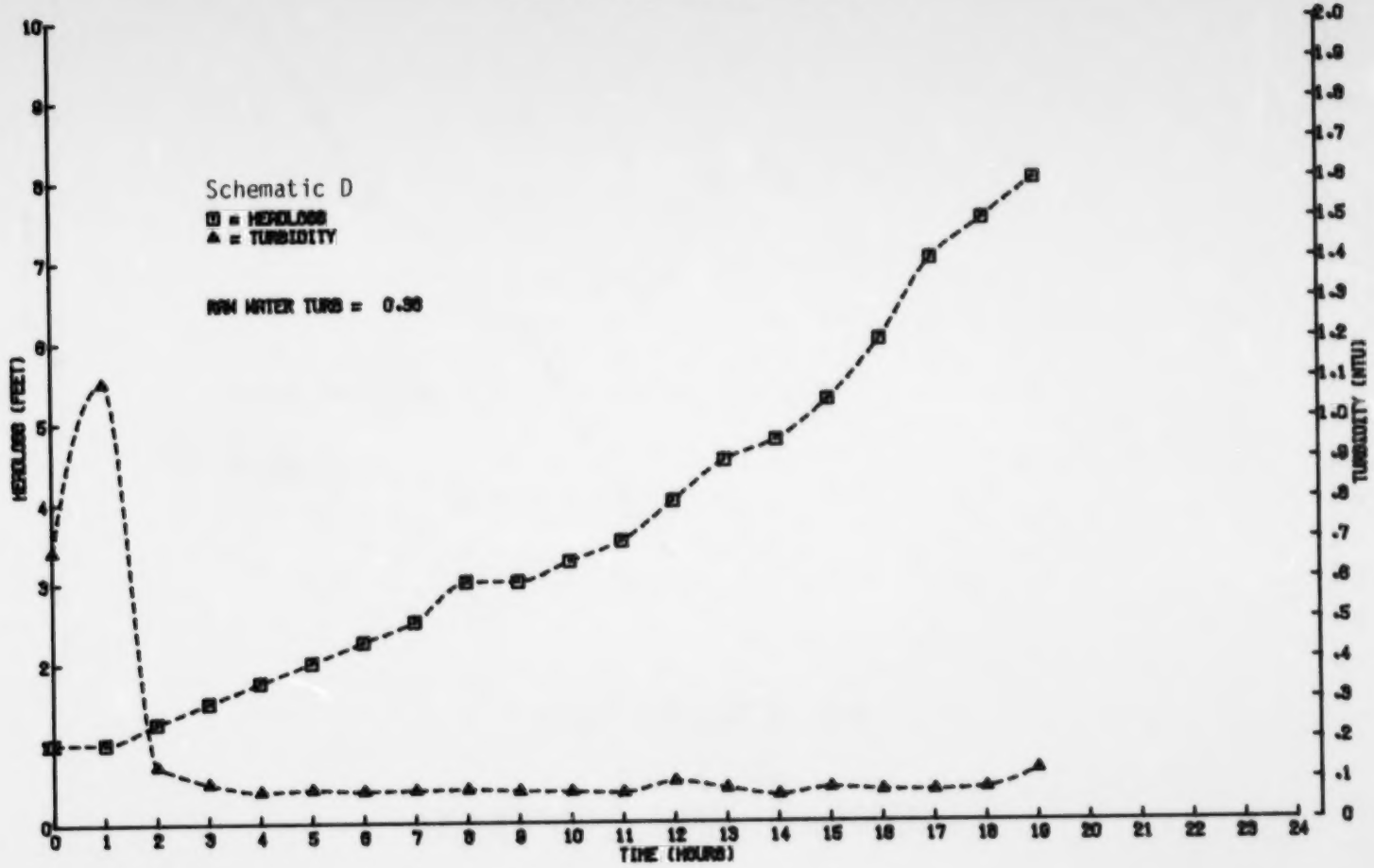
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 92M



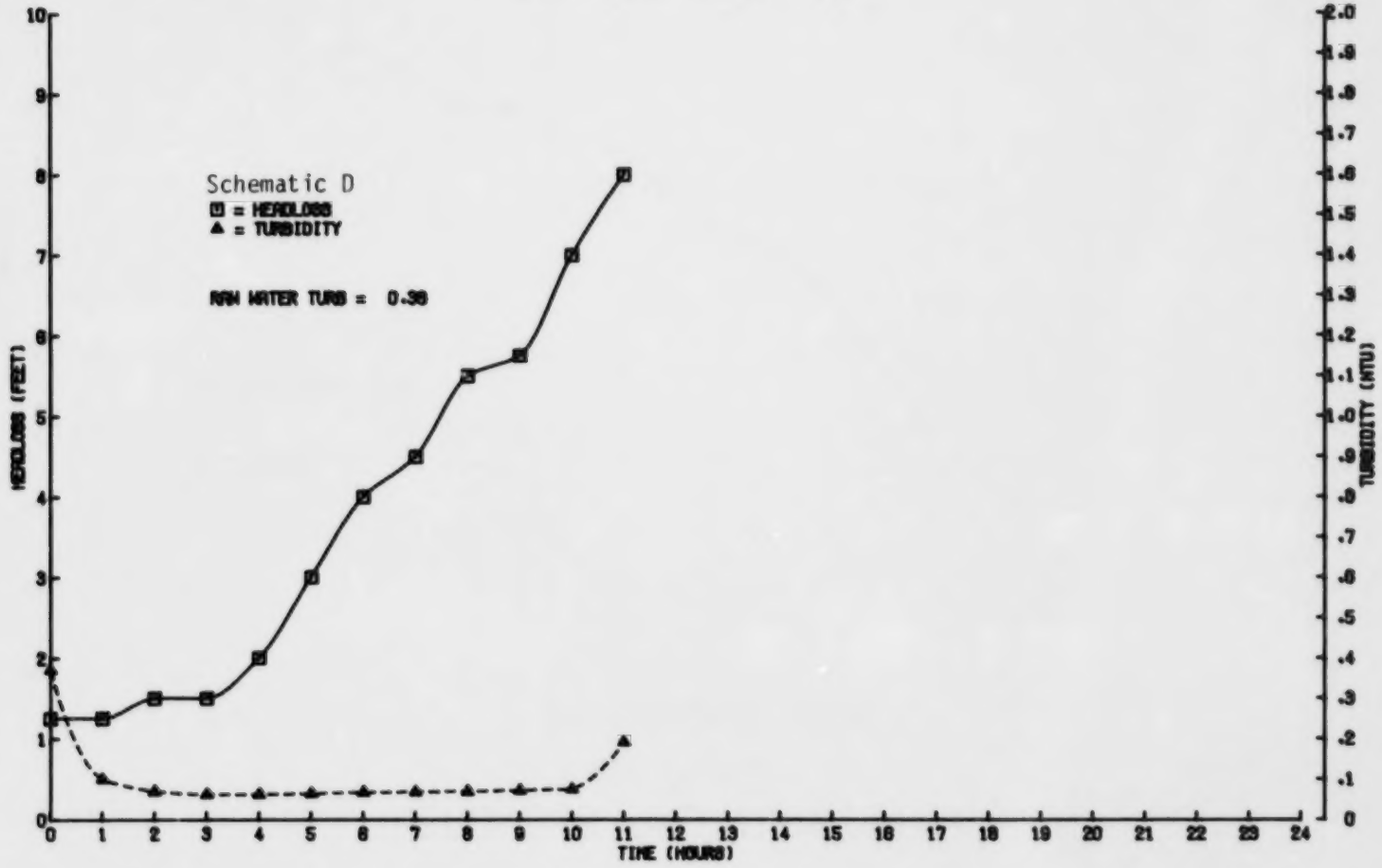
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 93



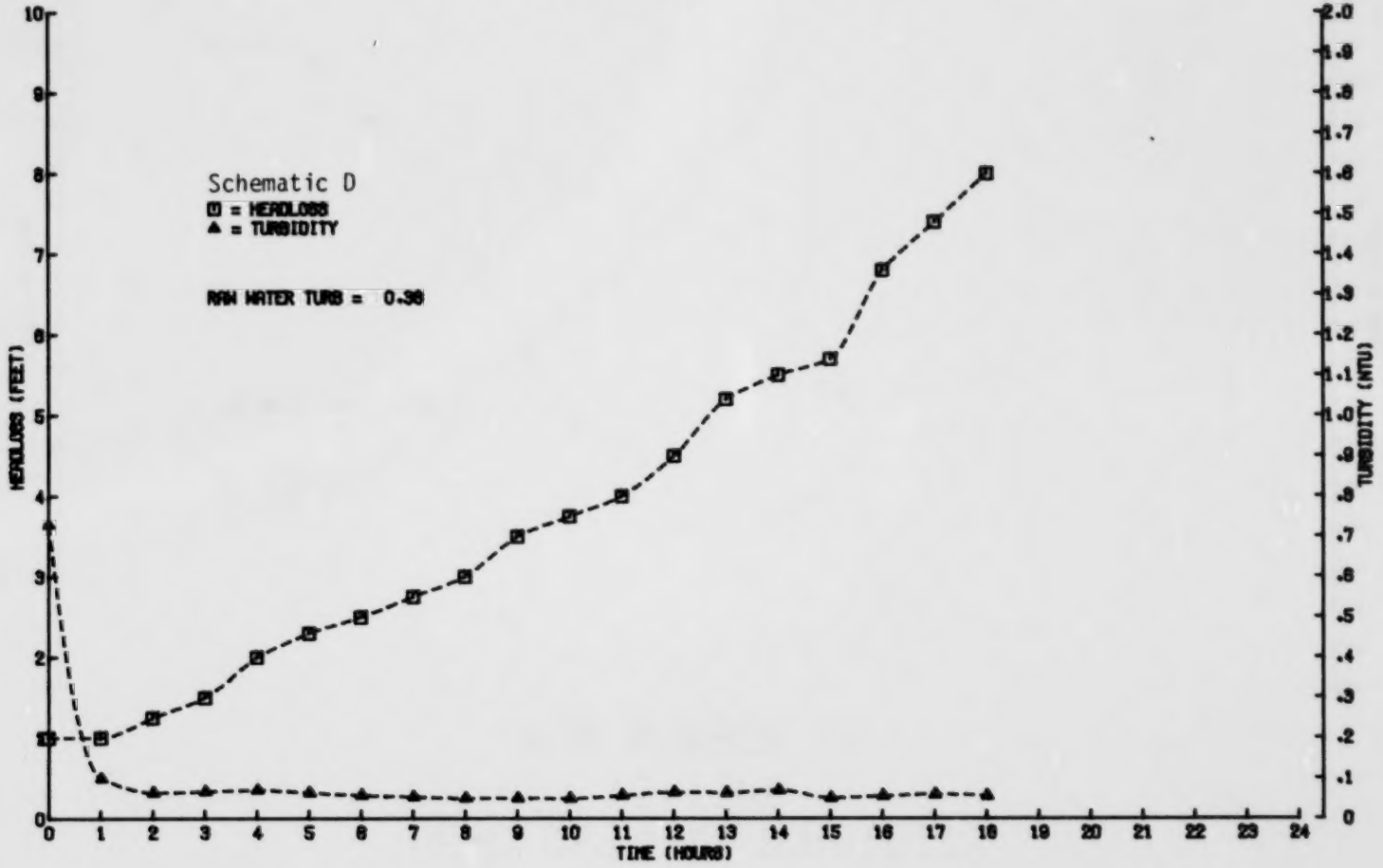
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 93M



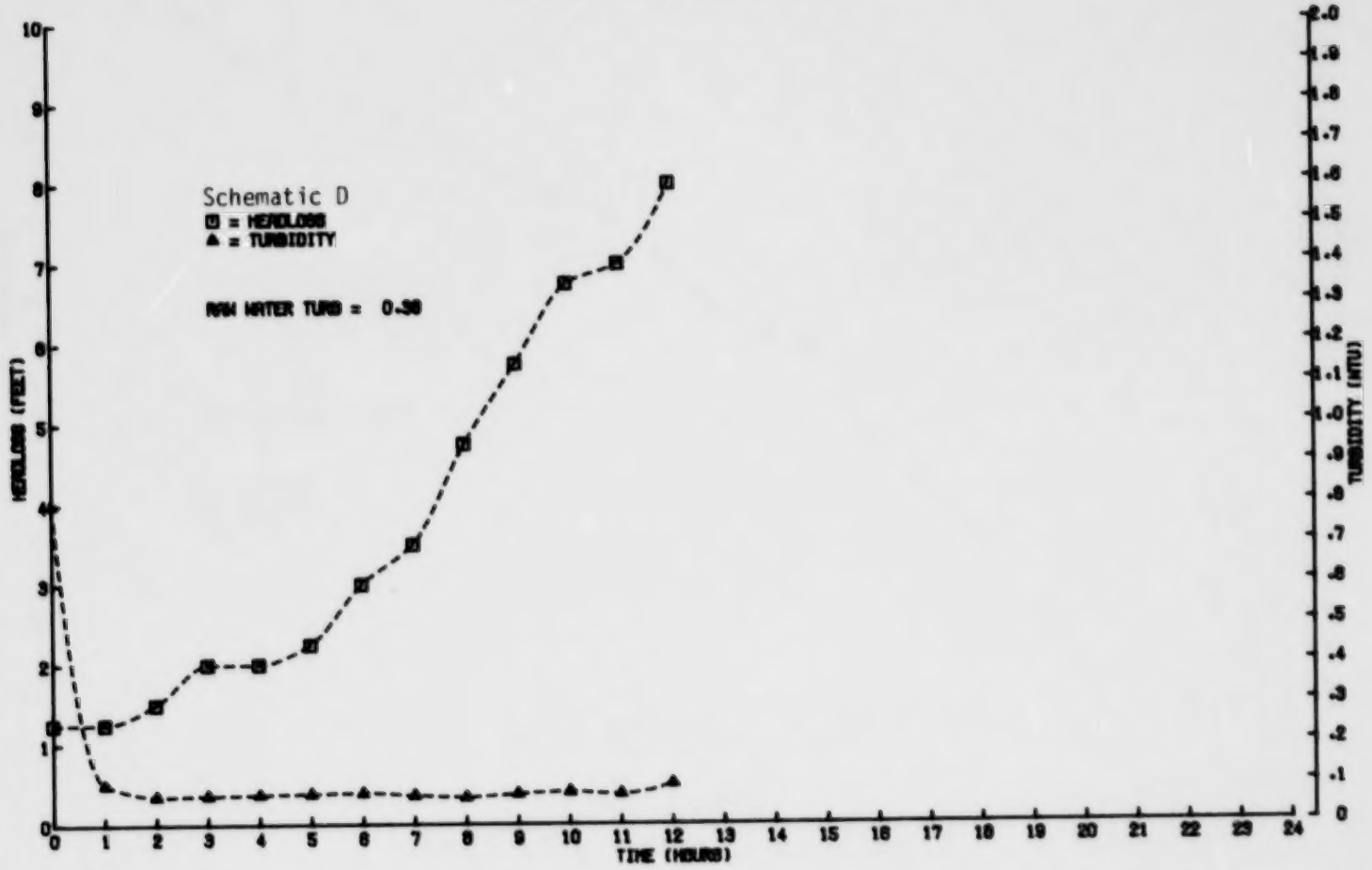
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 94



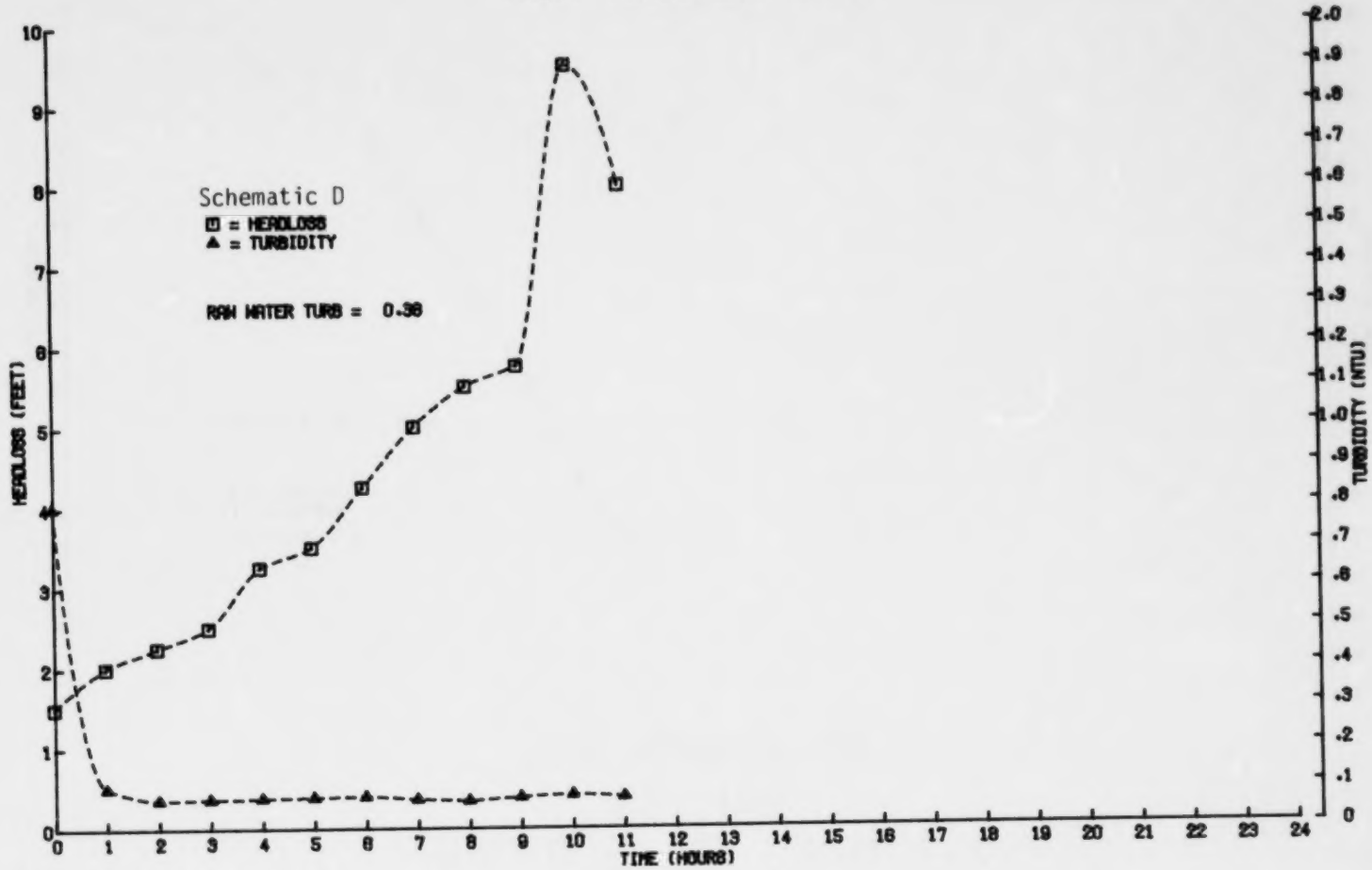
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 94M



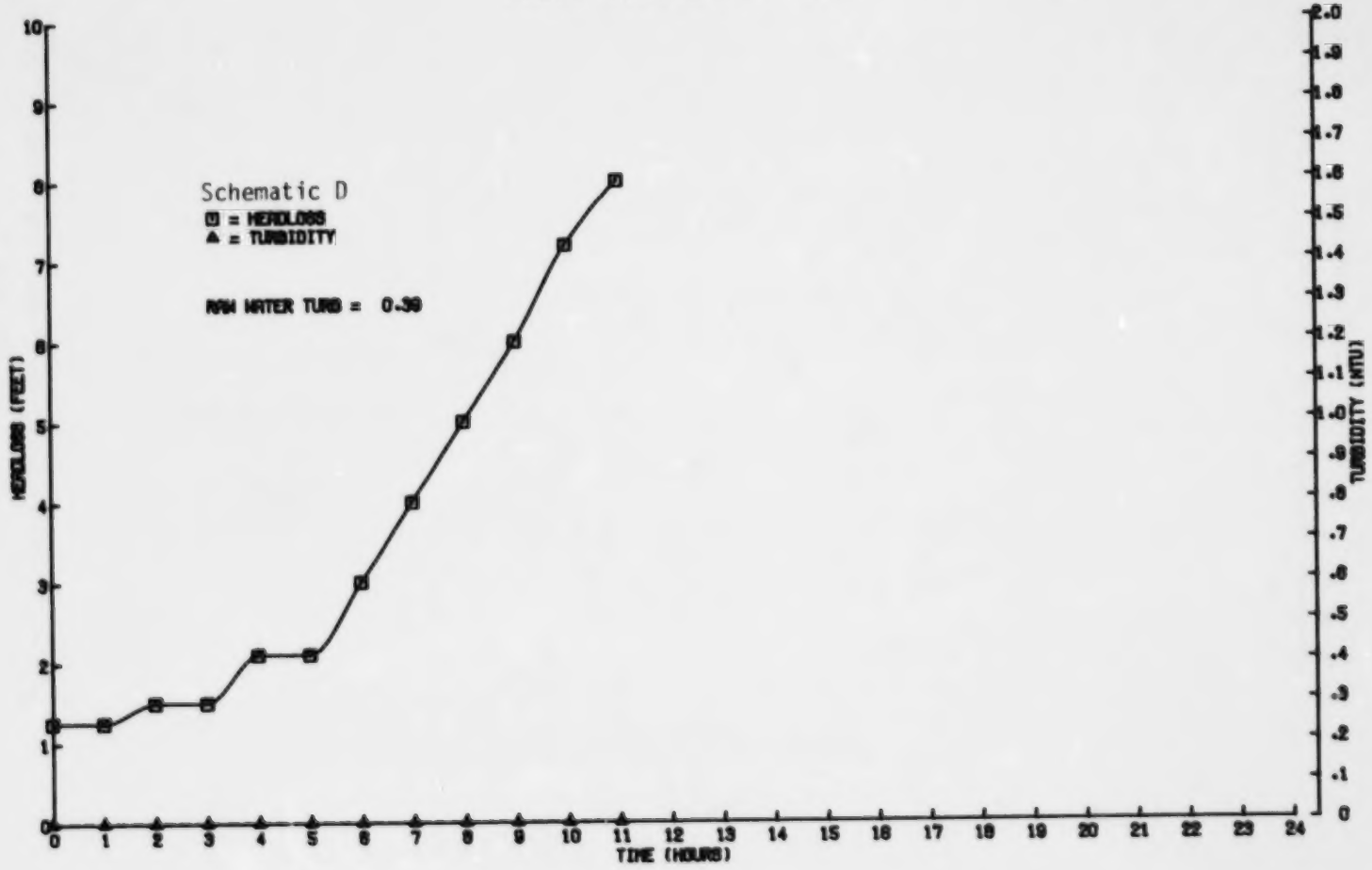
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 95



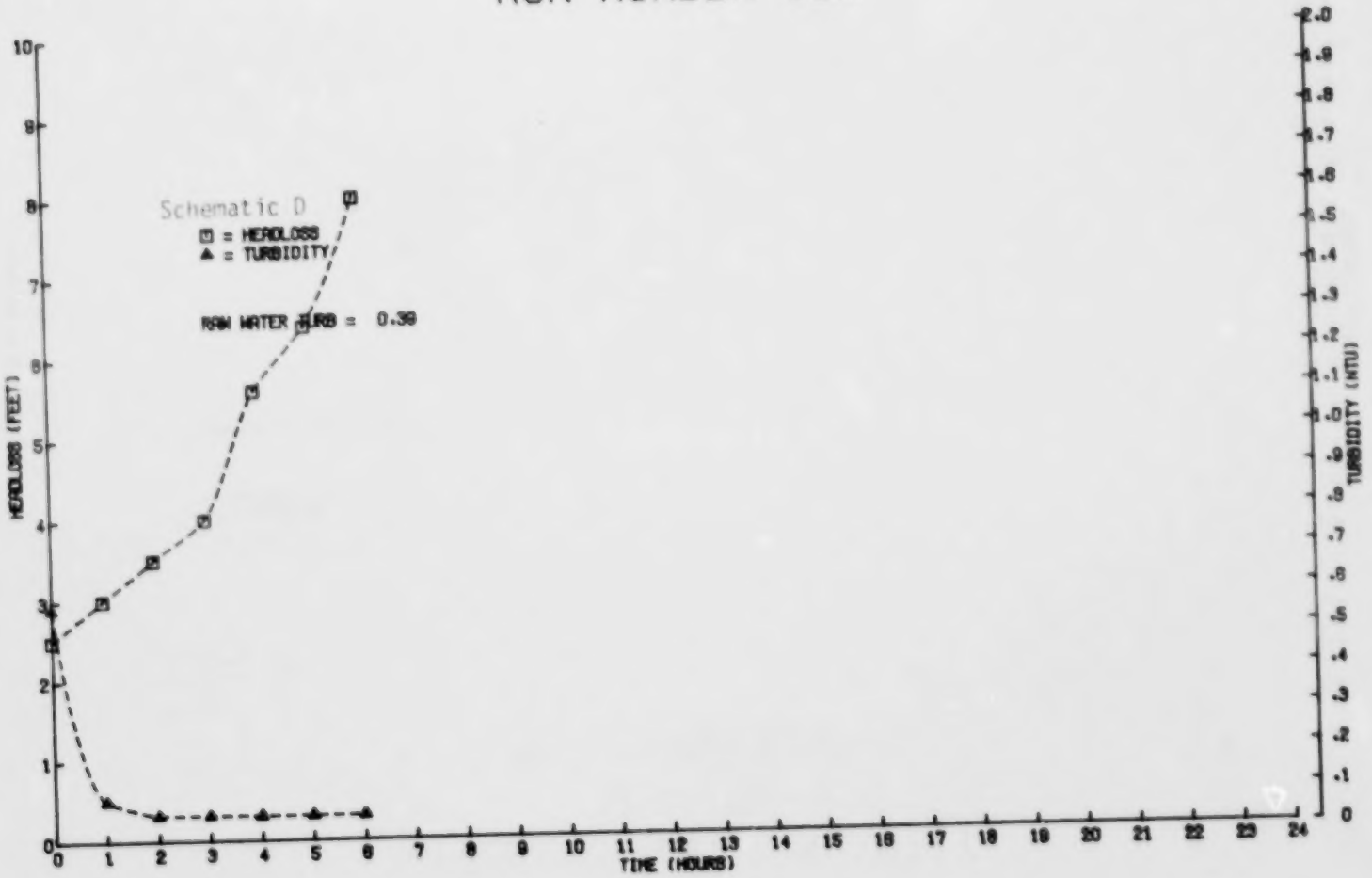
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 95M



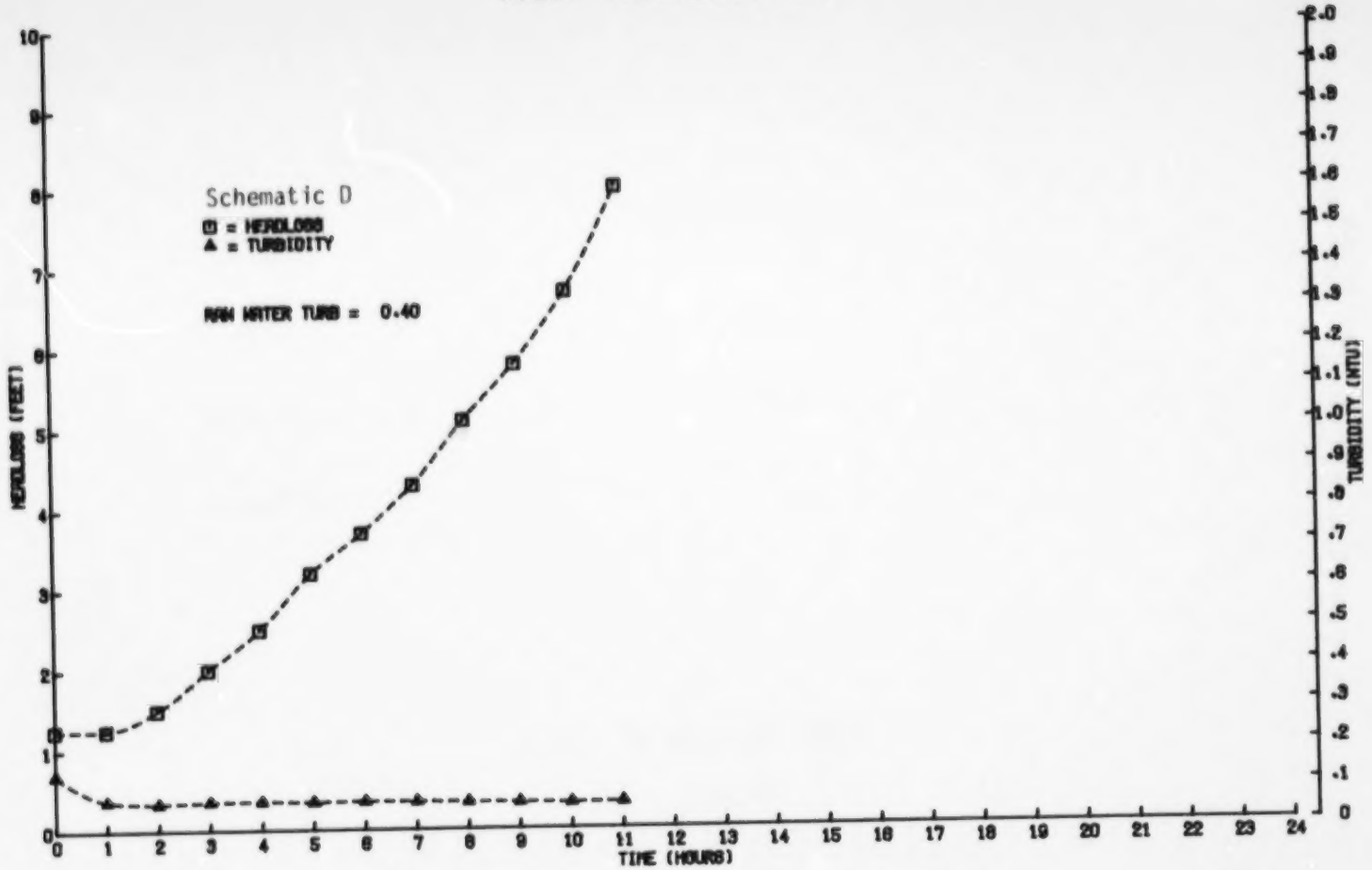
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 96



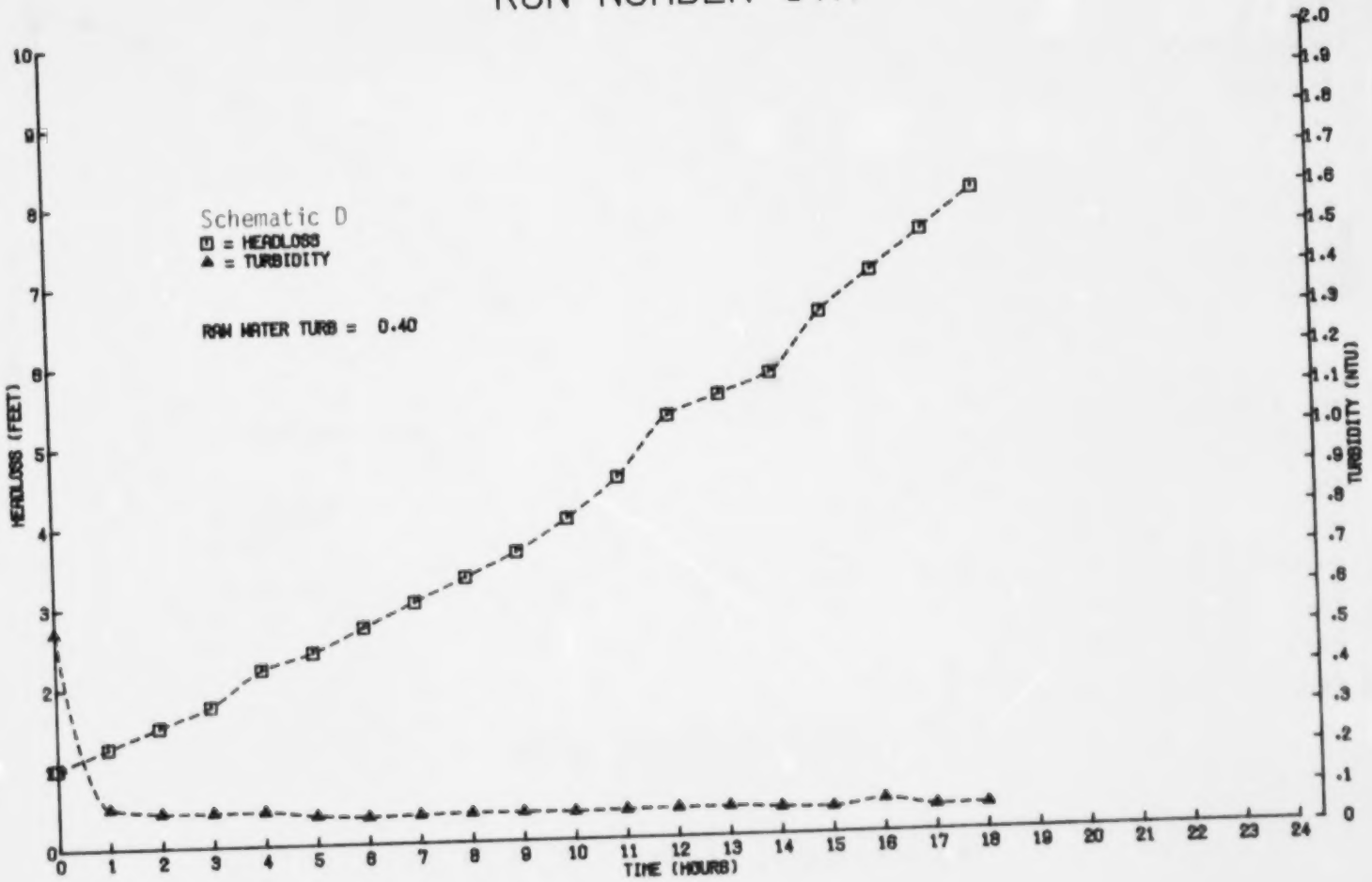
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 96M



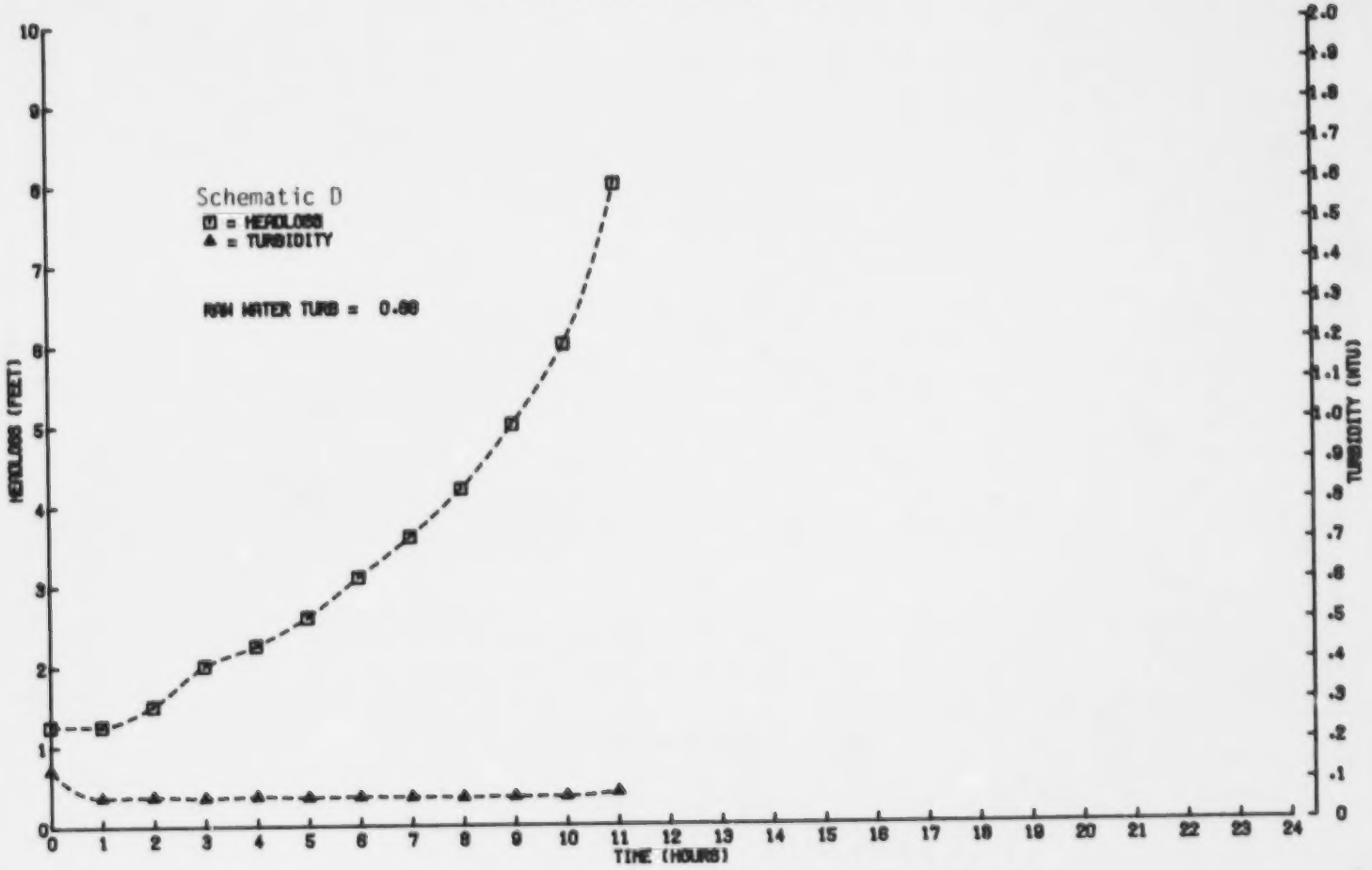
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 97



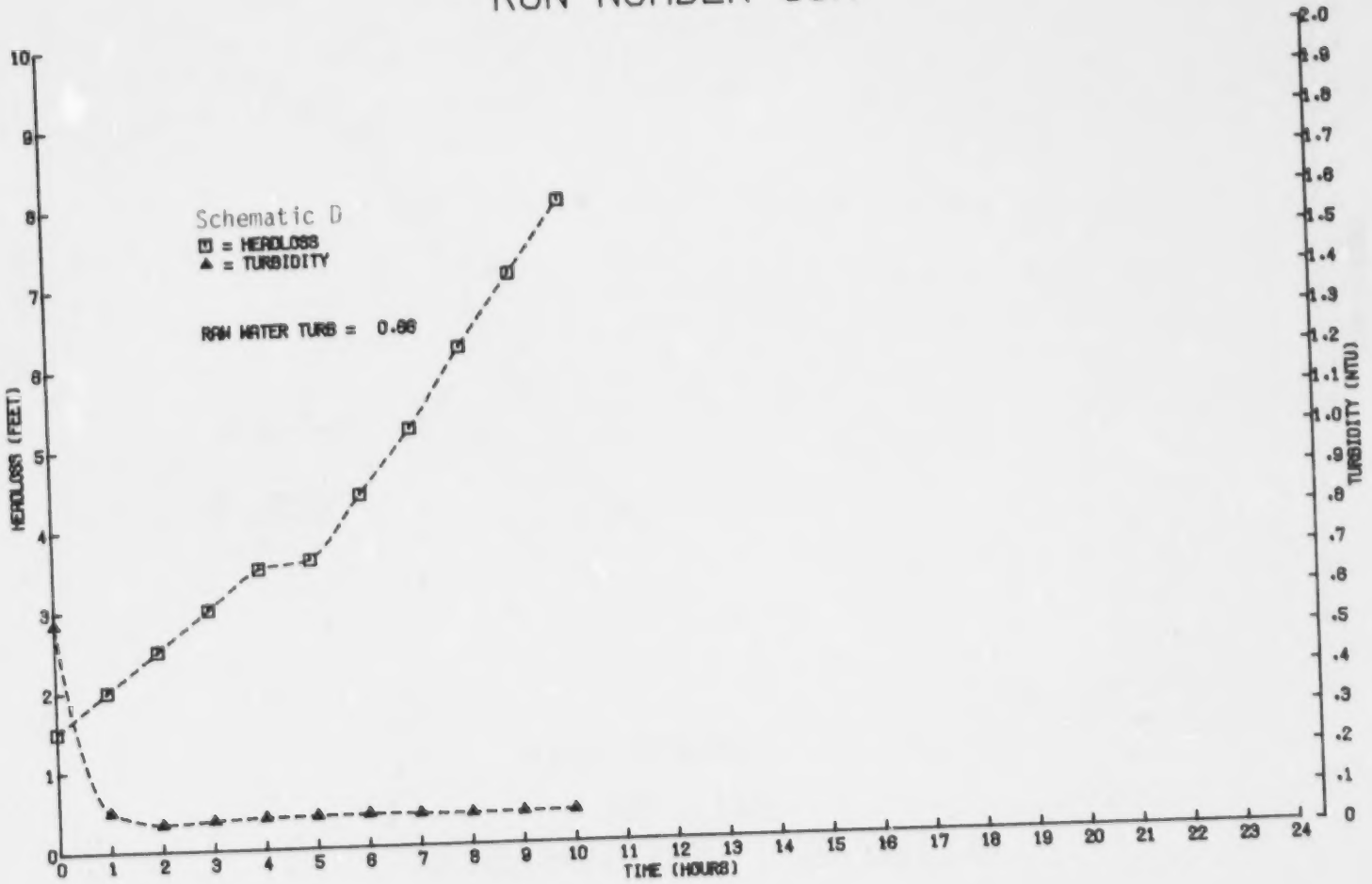
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 97M



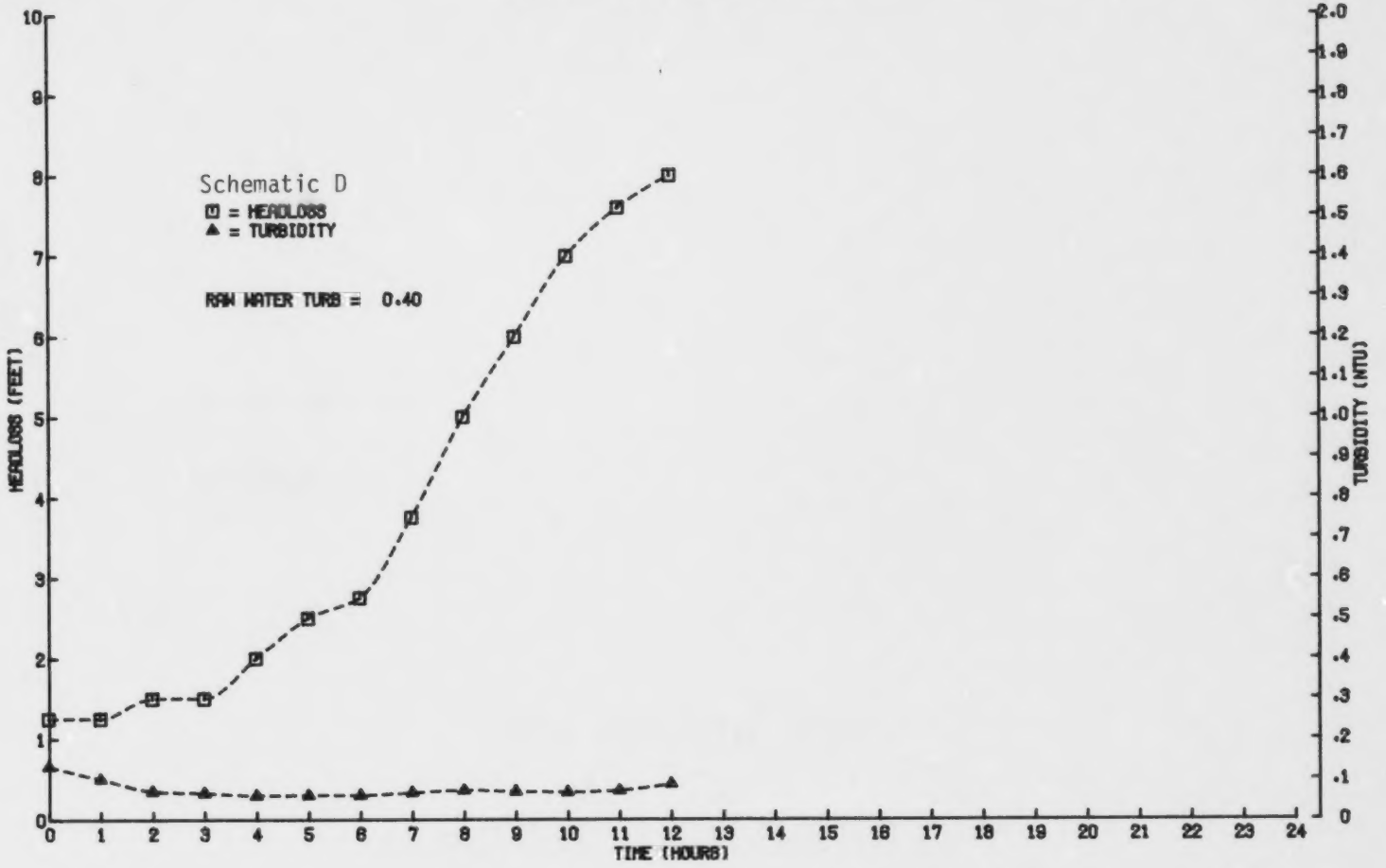
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 98



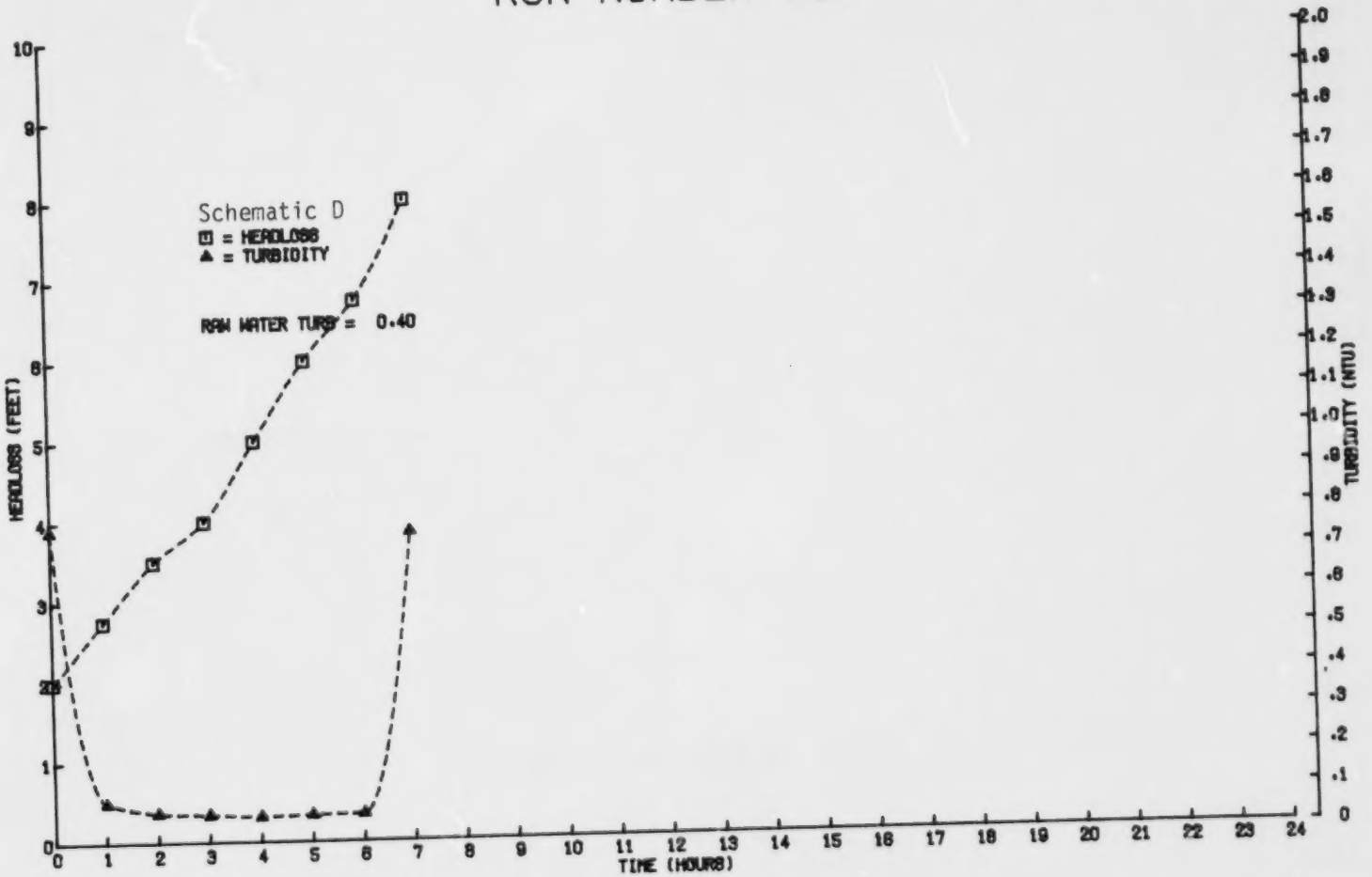
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 98M



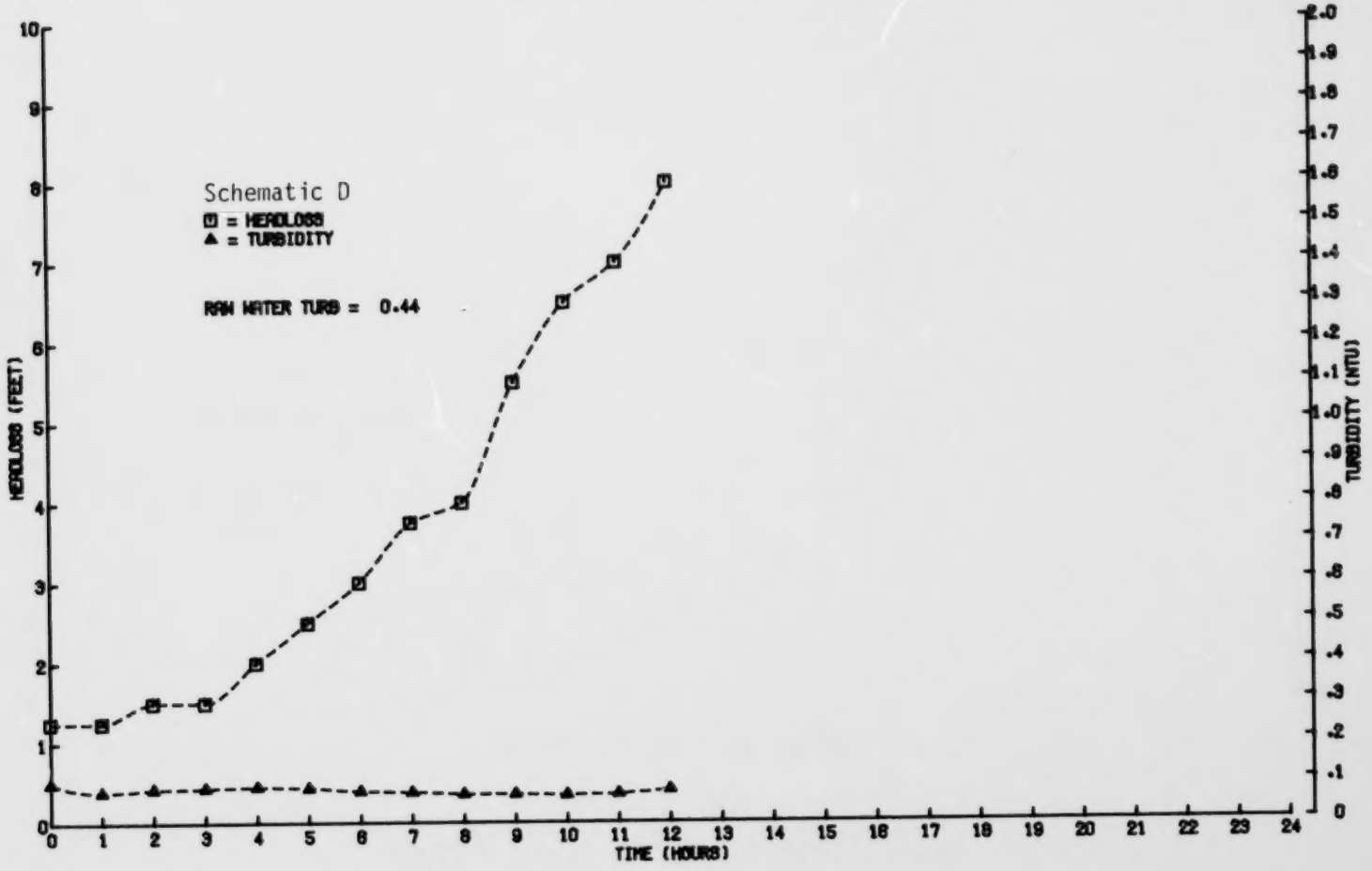
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 99



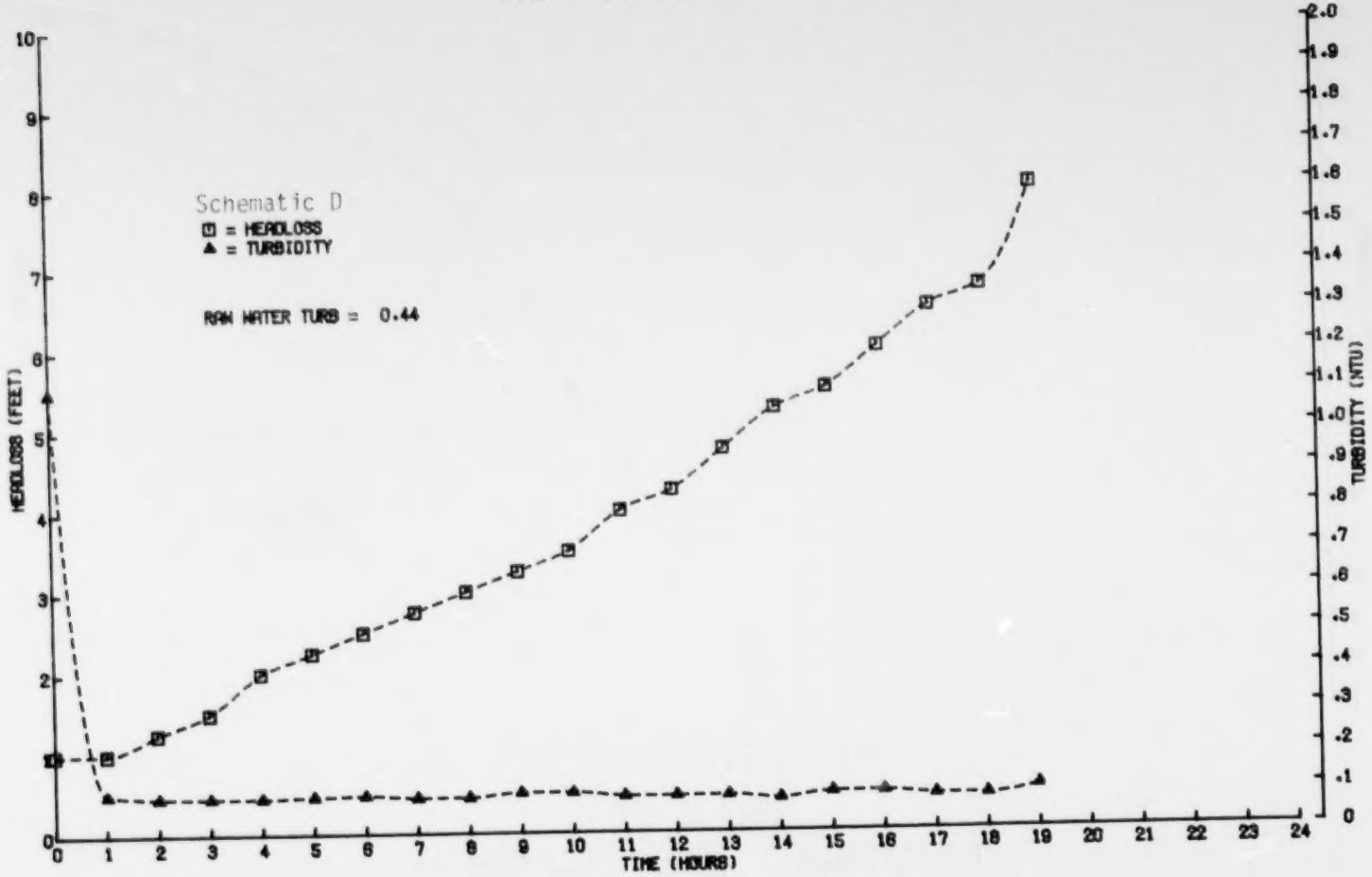
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 99M



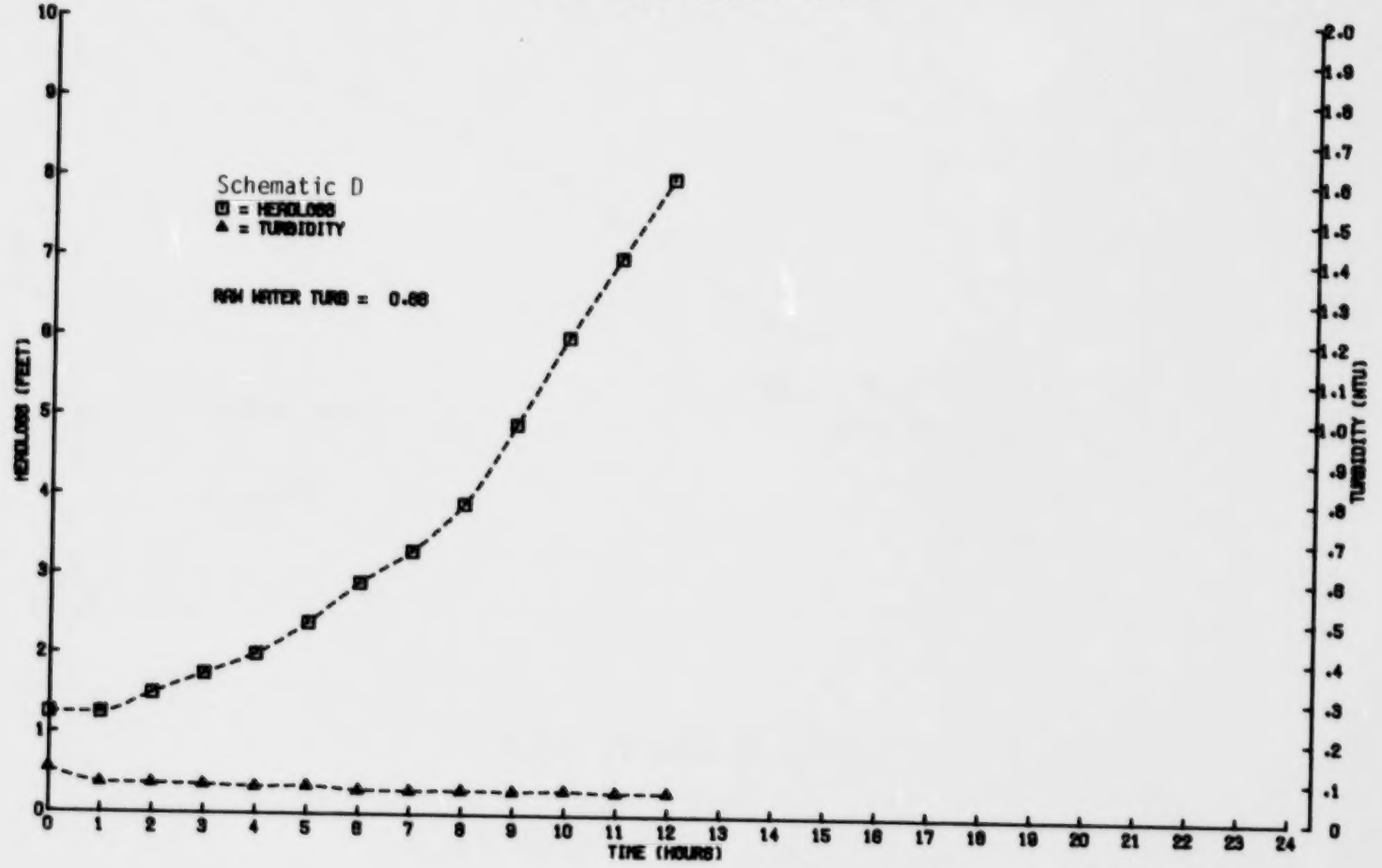
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 100



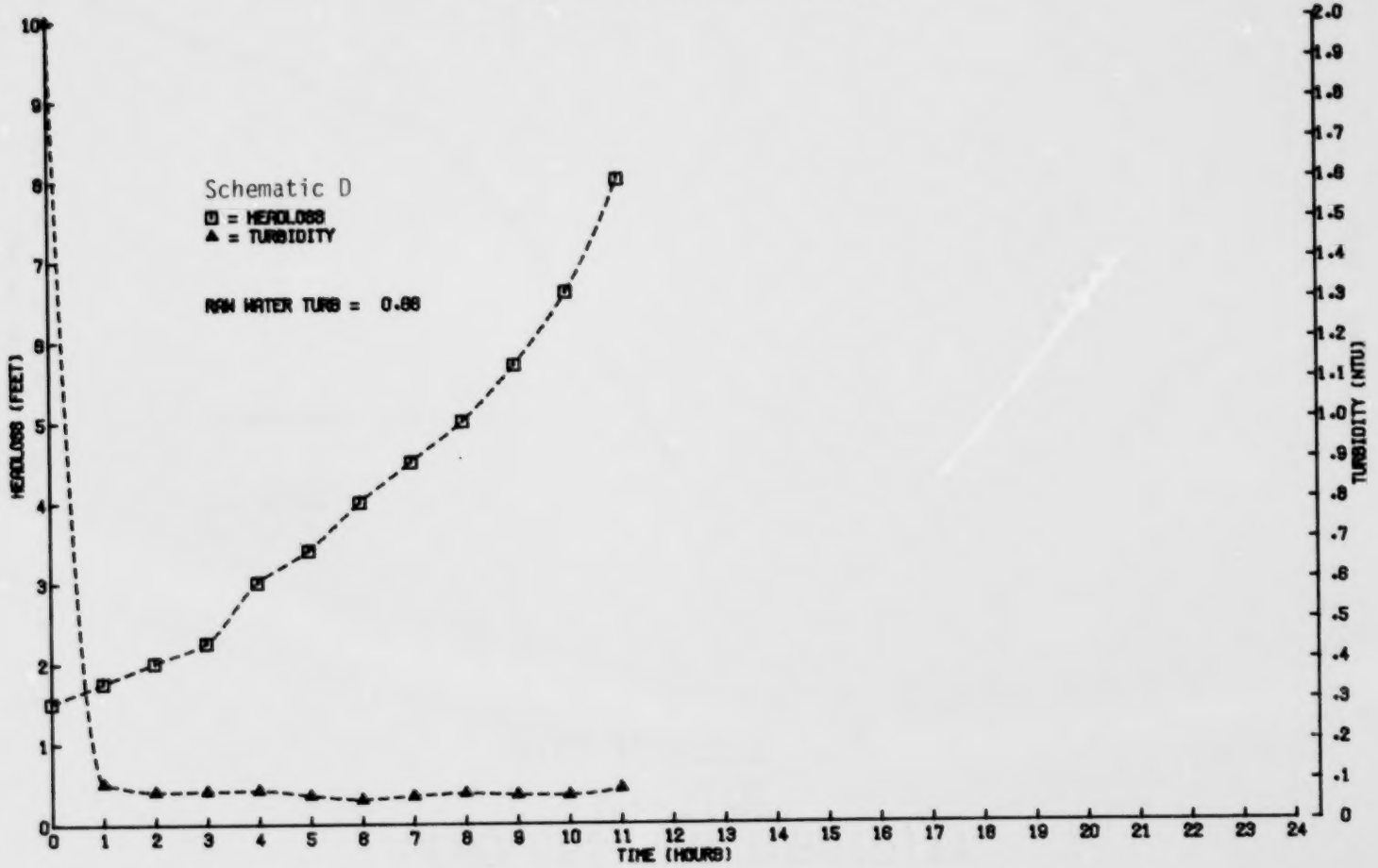
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 100M



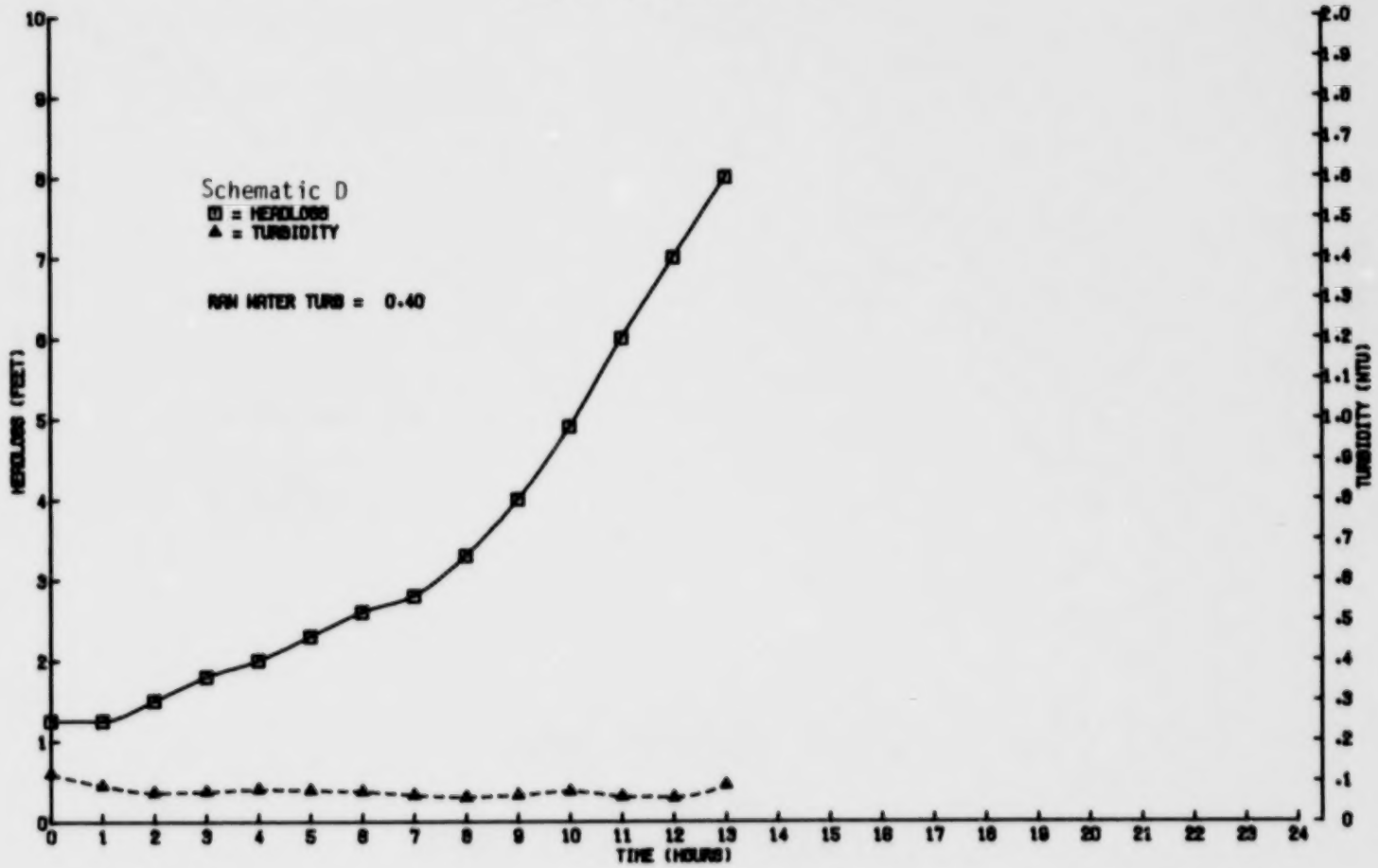
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 101



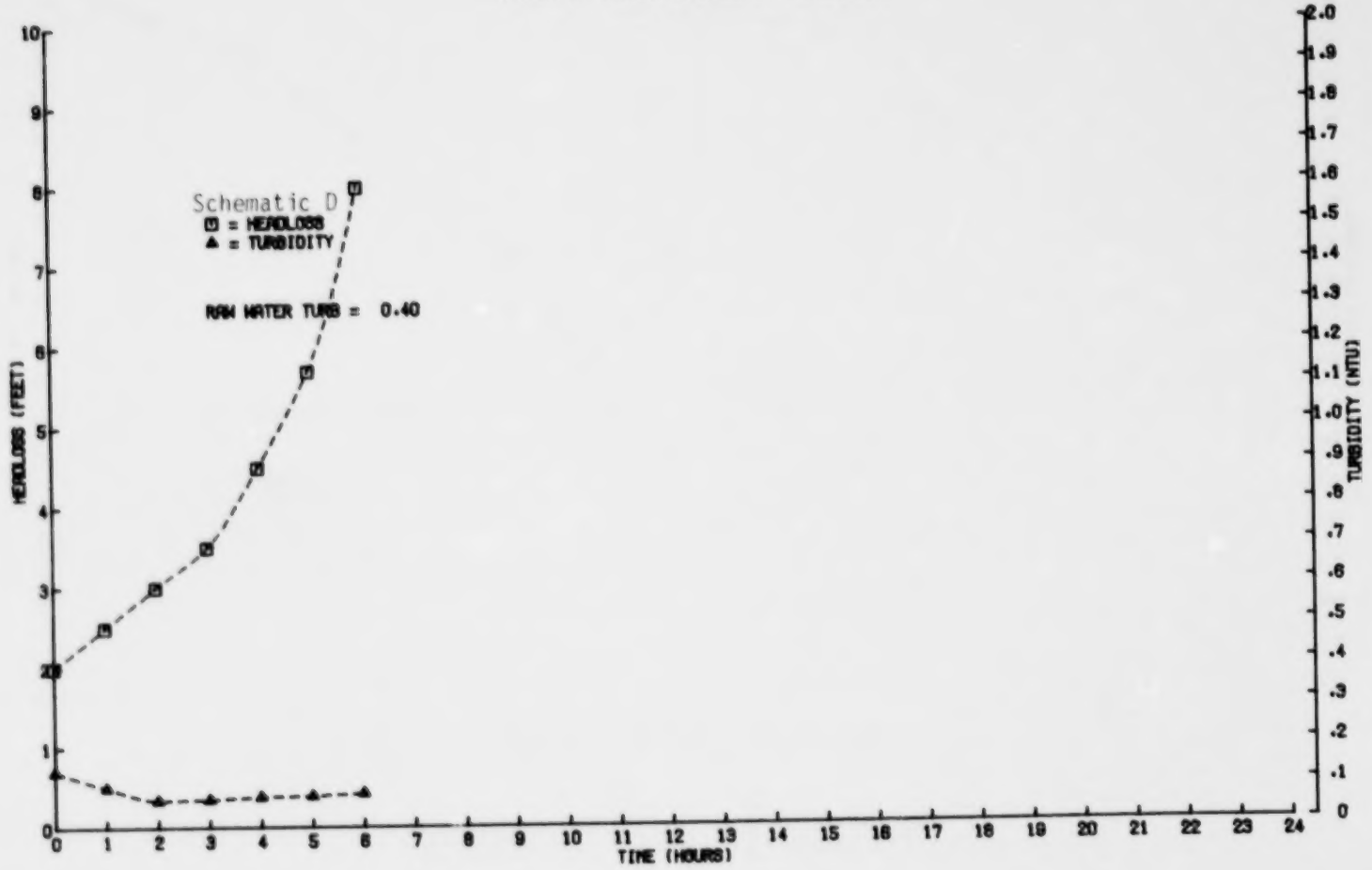
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 101M



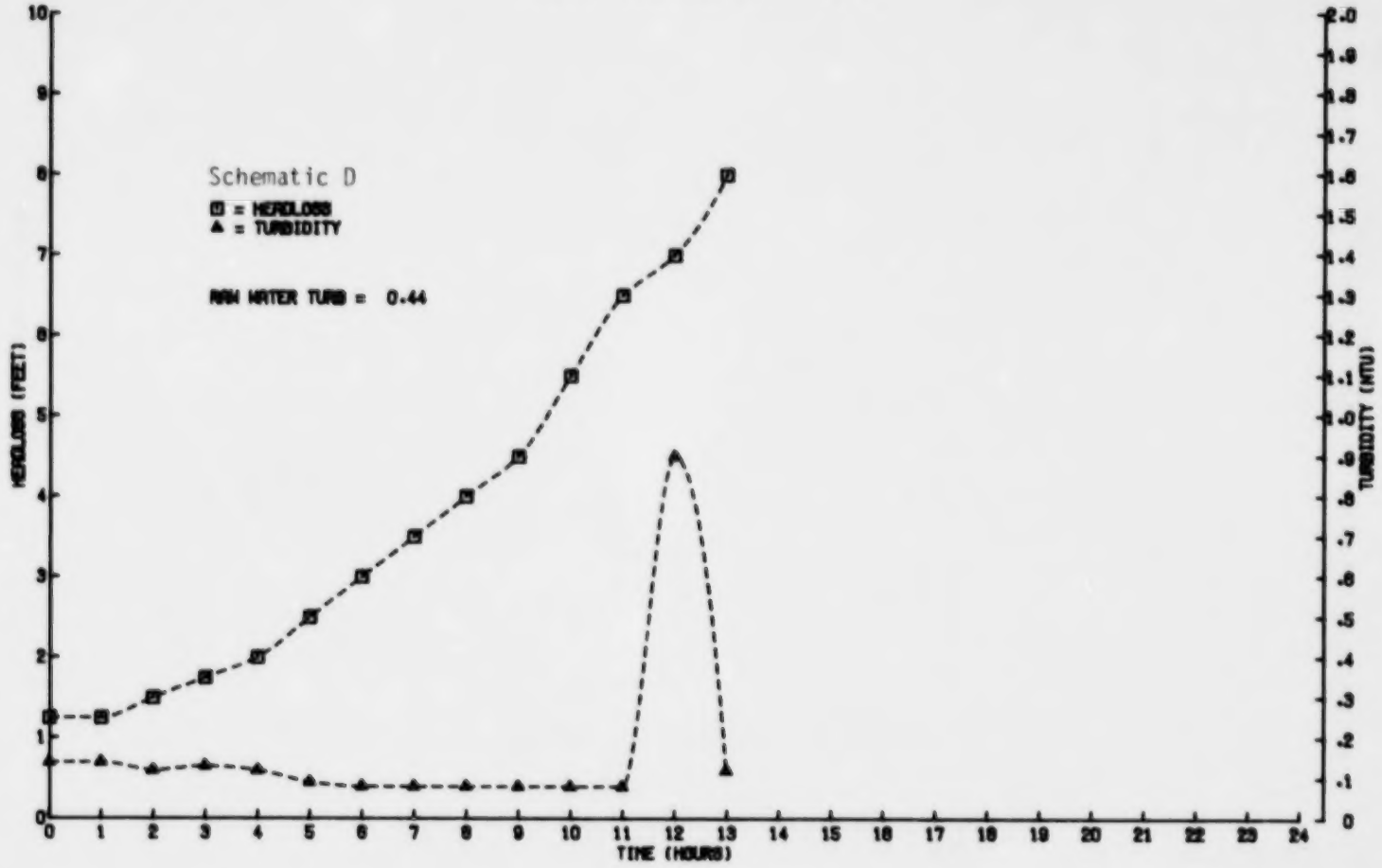
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 102



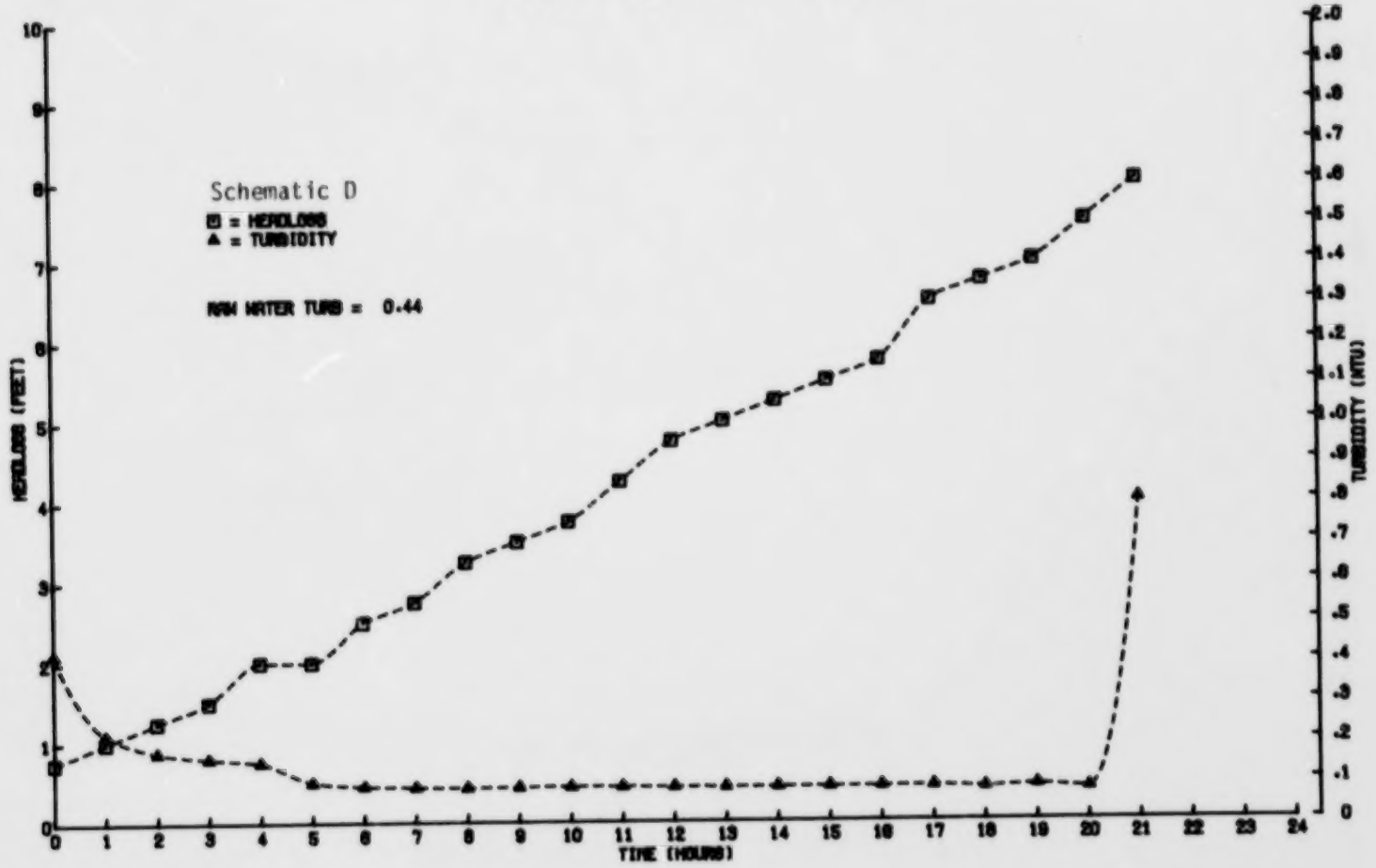
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 102M



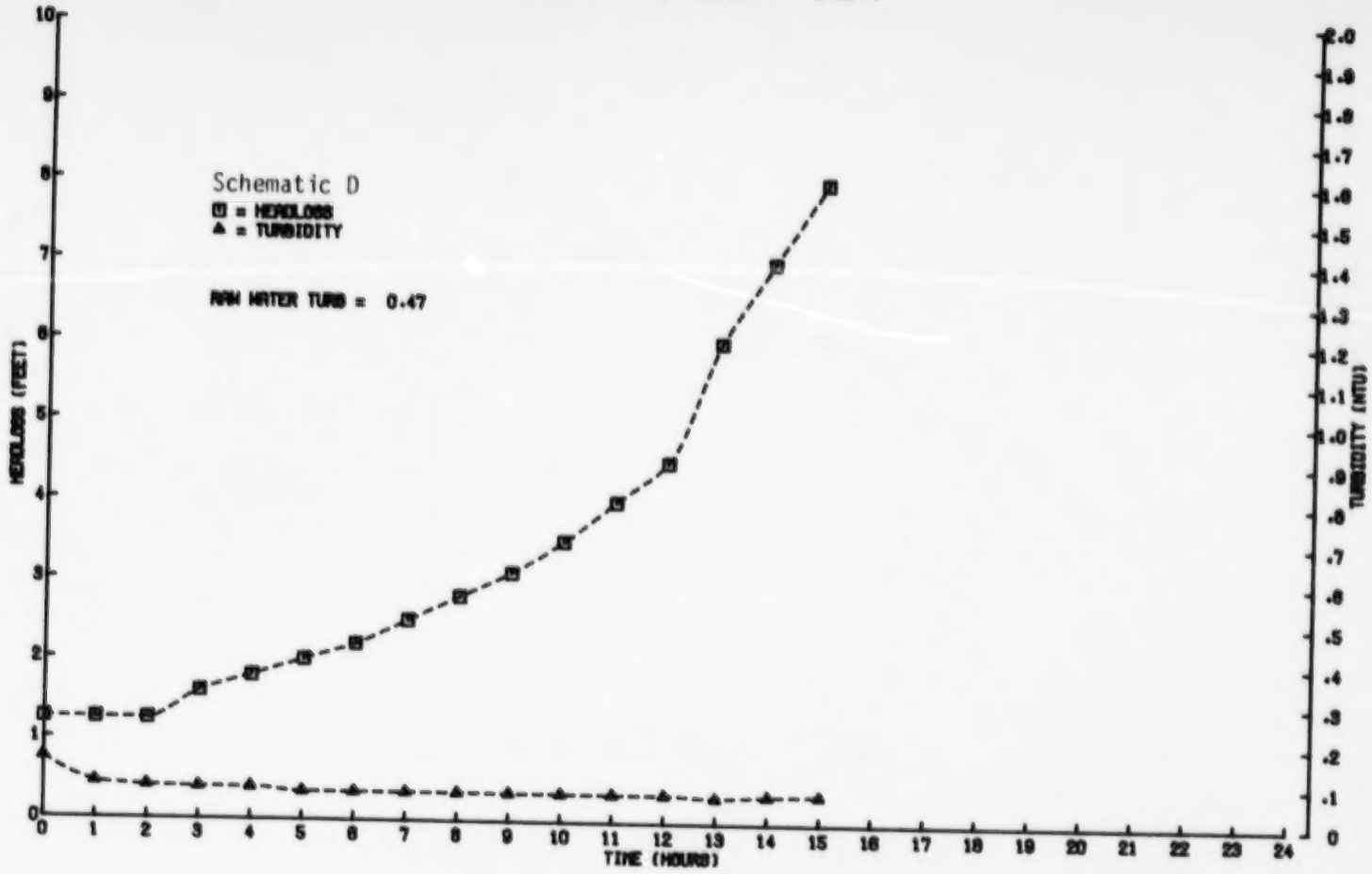
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 103



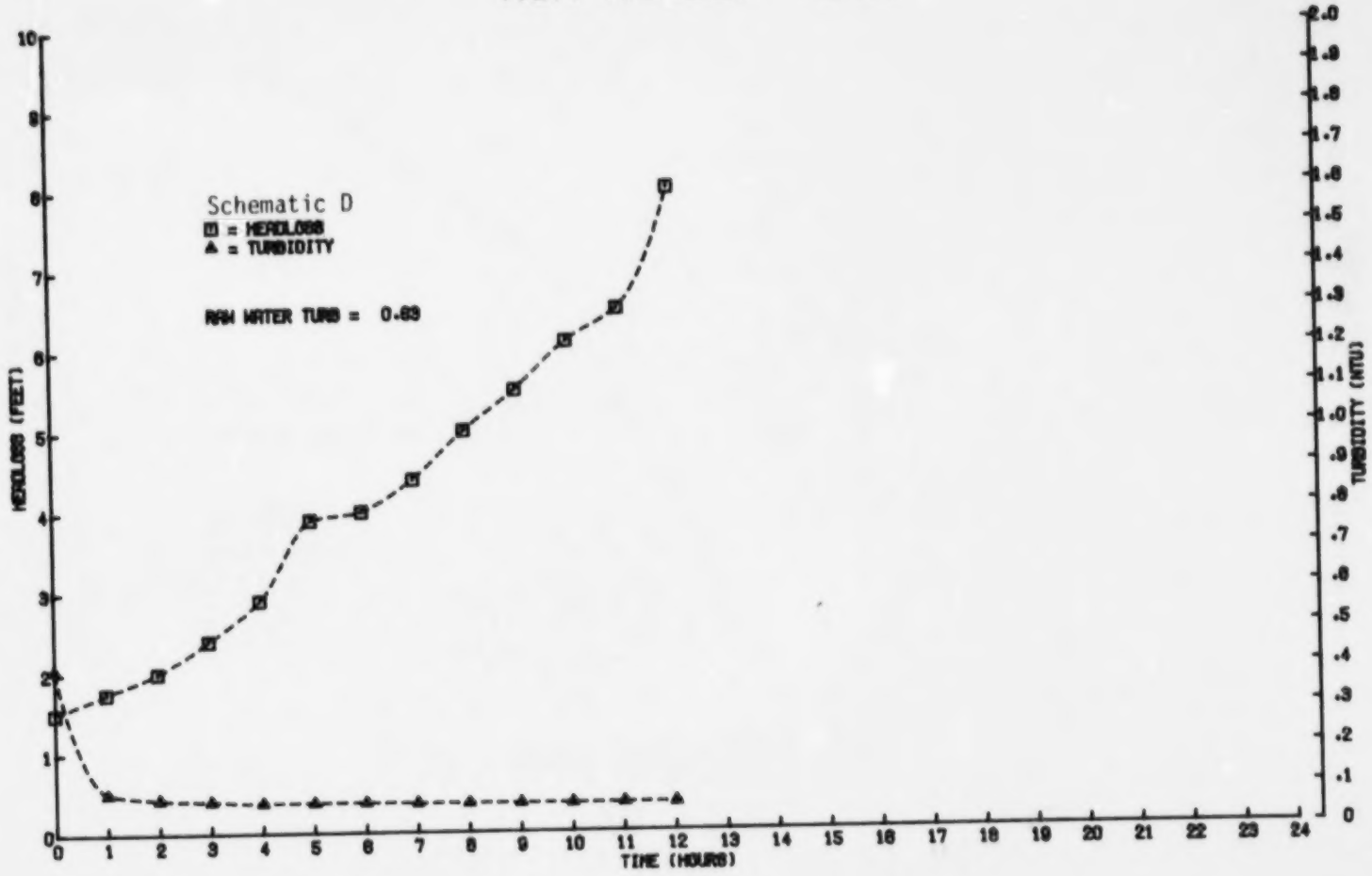
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 103M



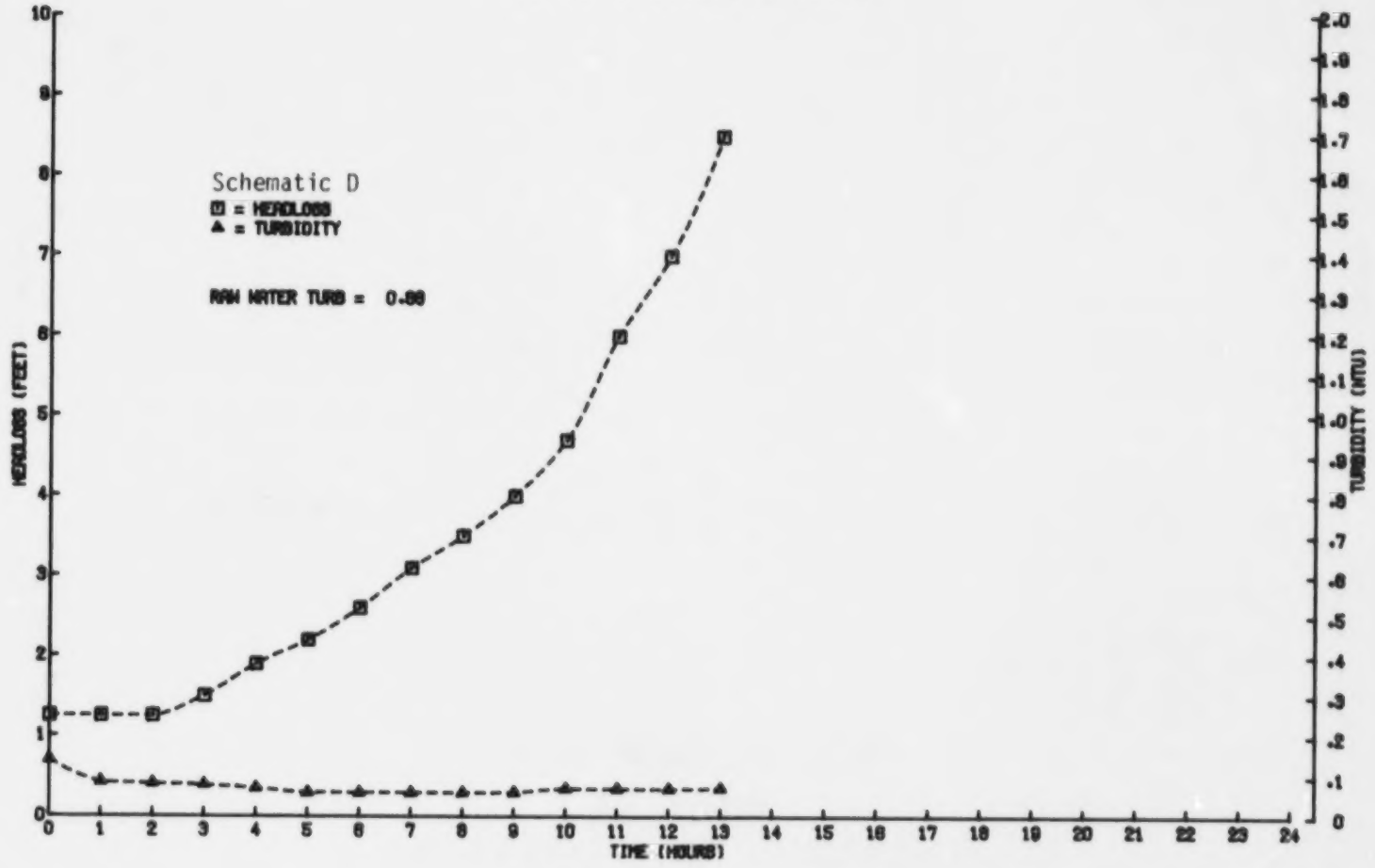
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 104



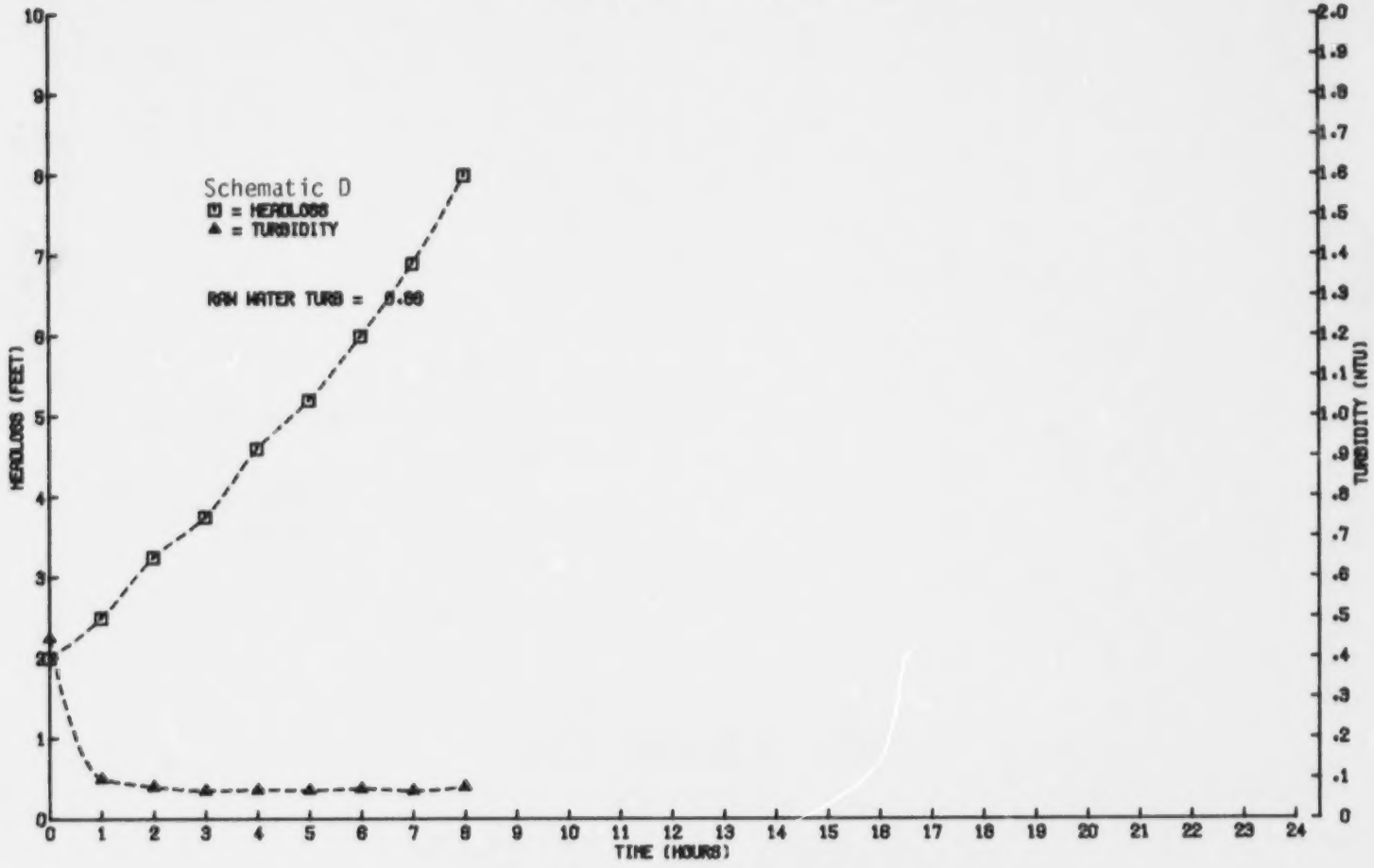
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 104M



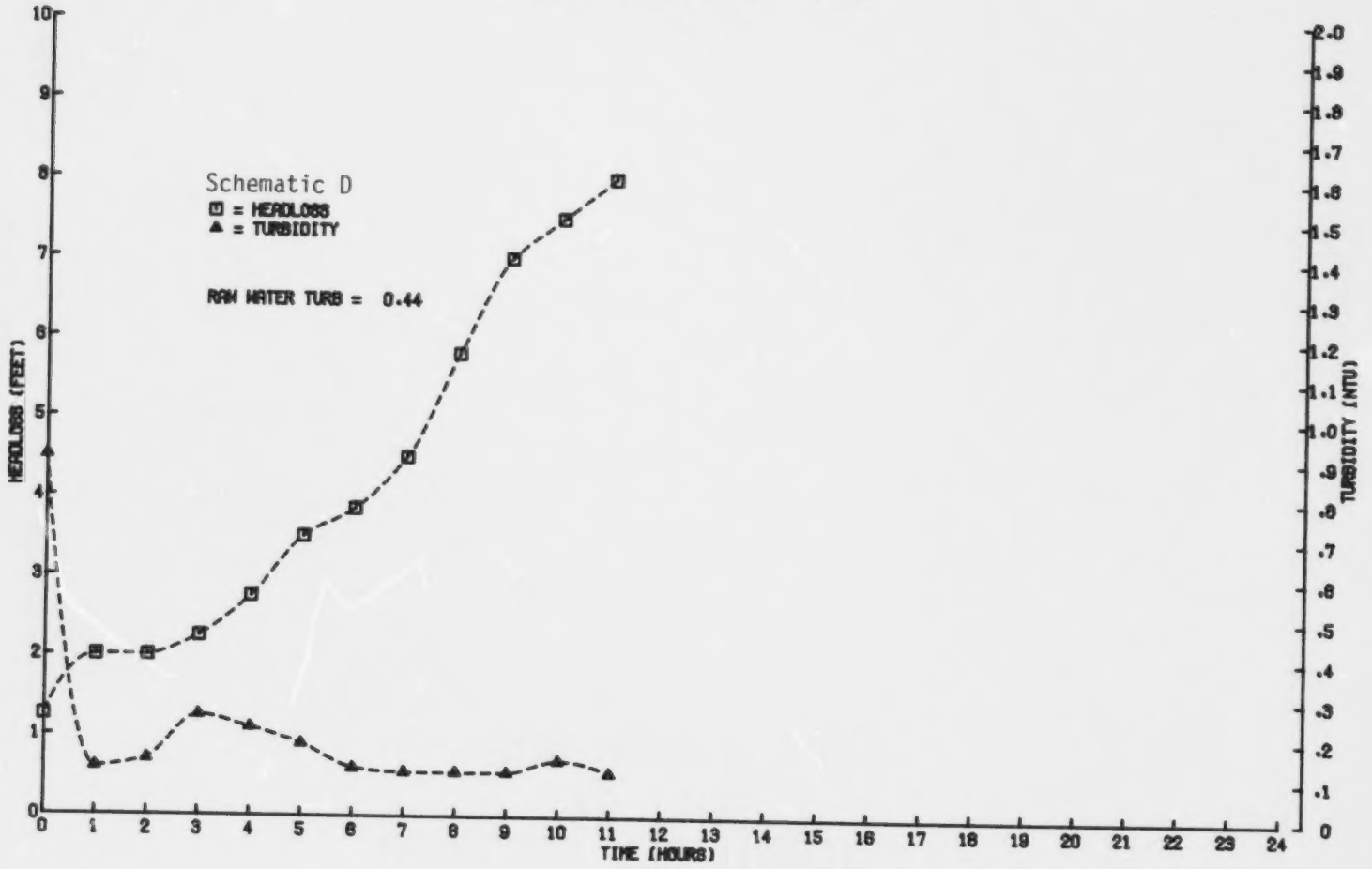
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 105



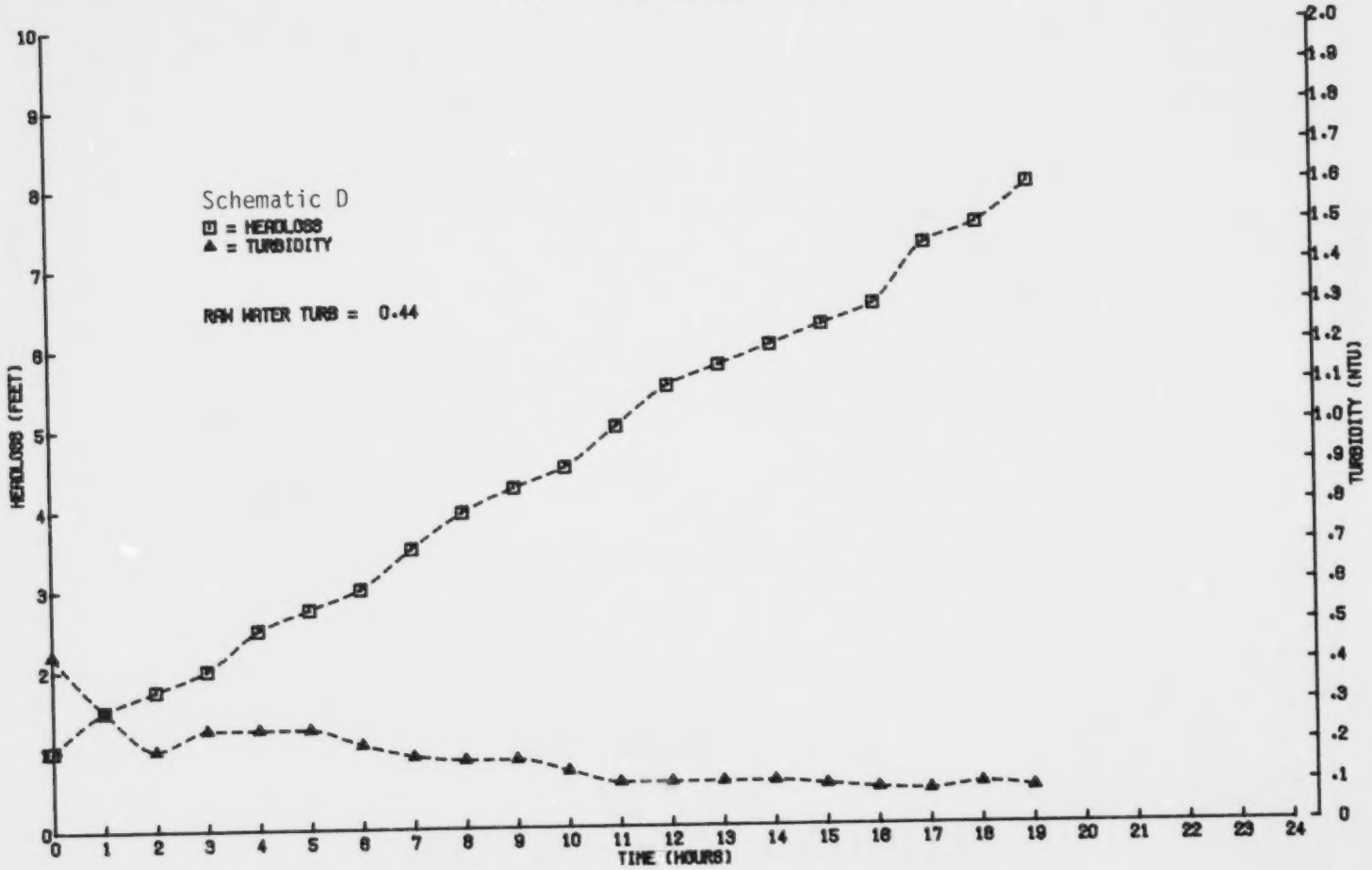
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 105M



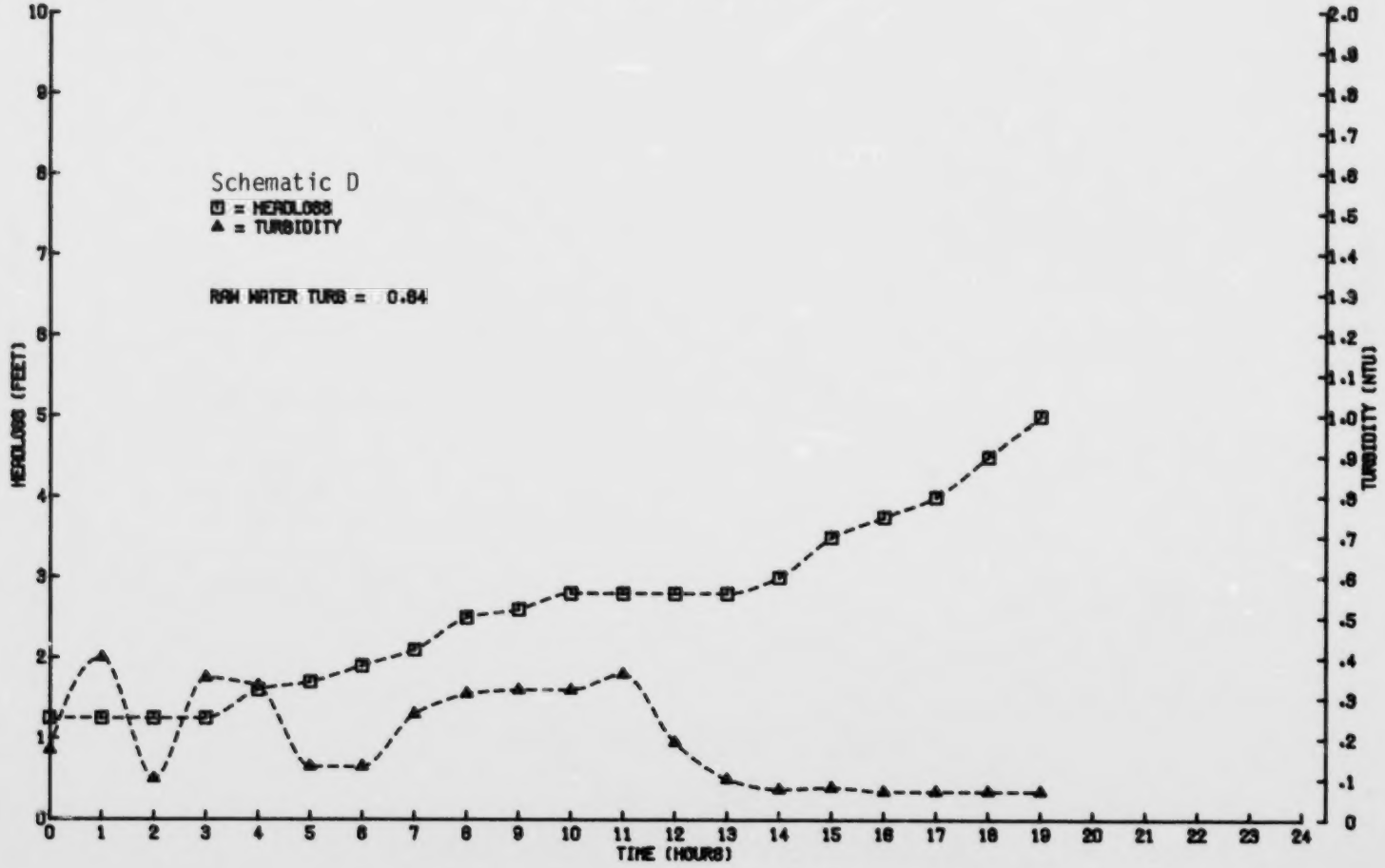
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 106



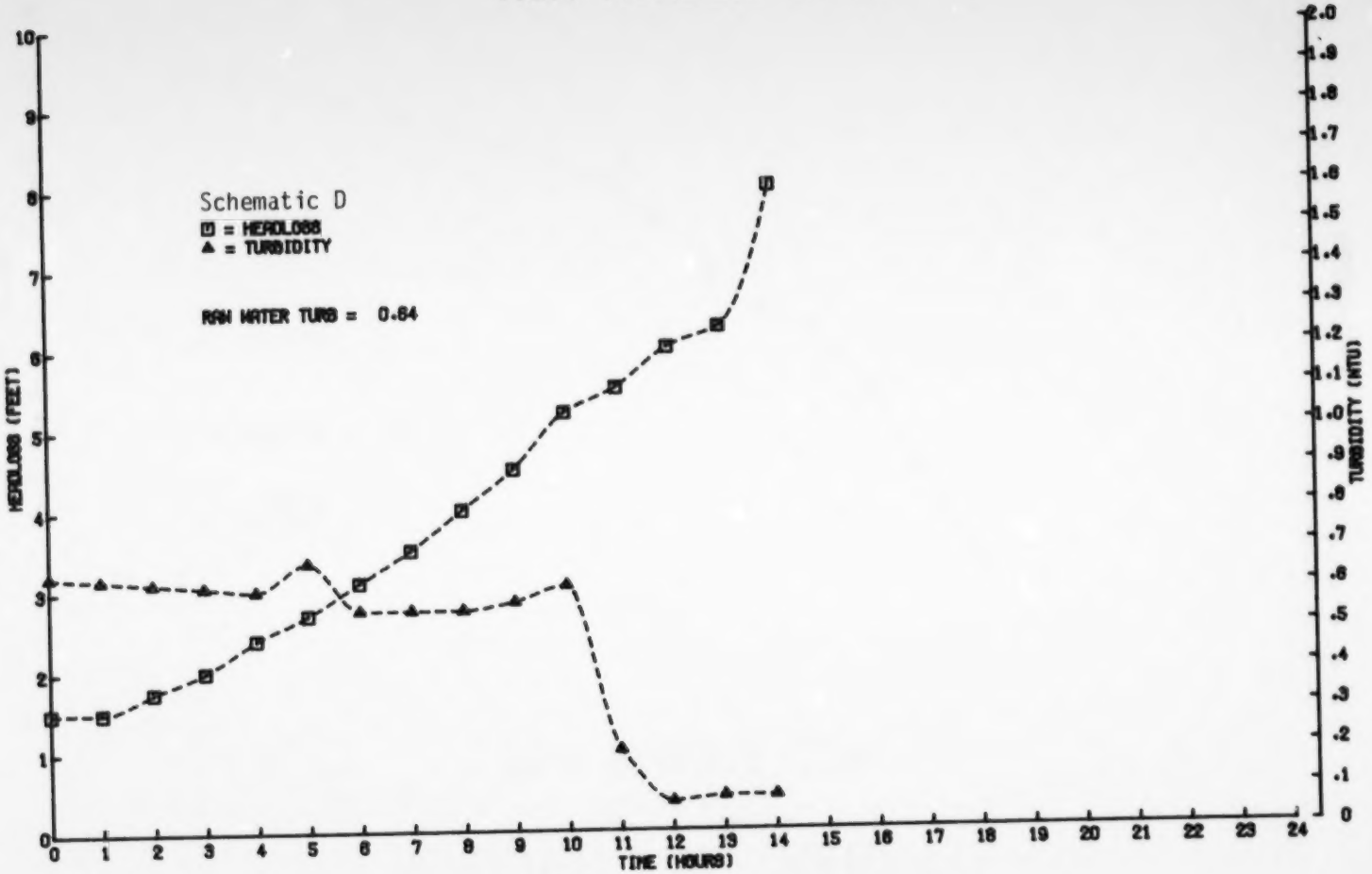
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 106M



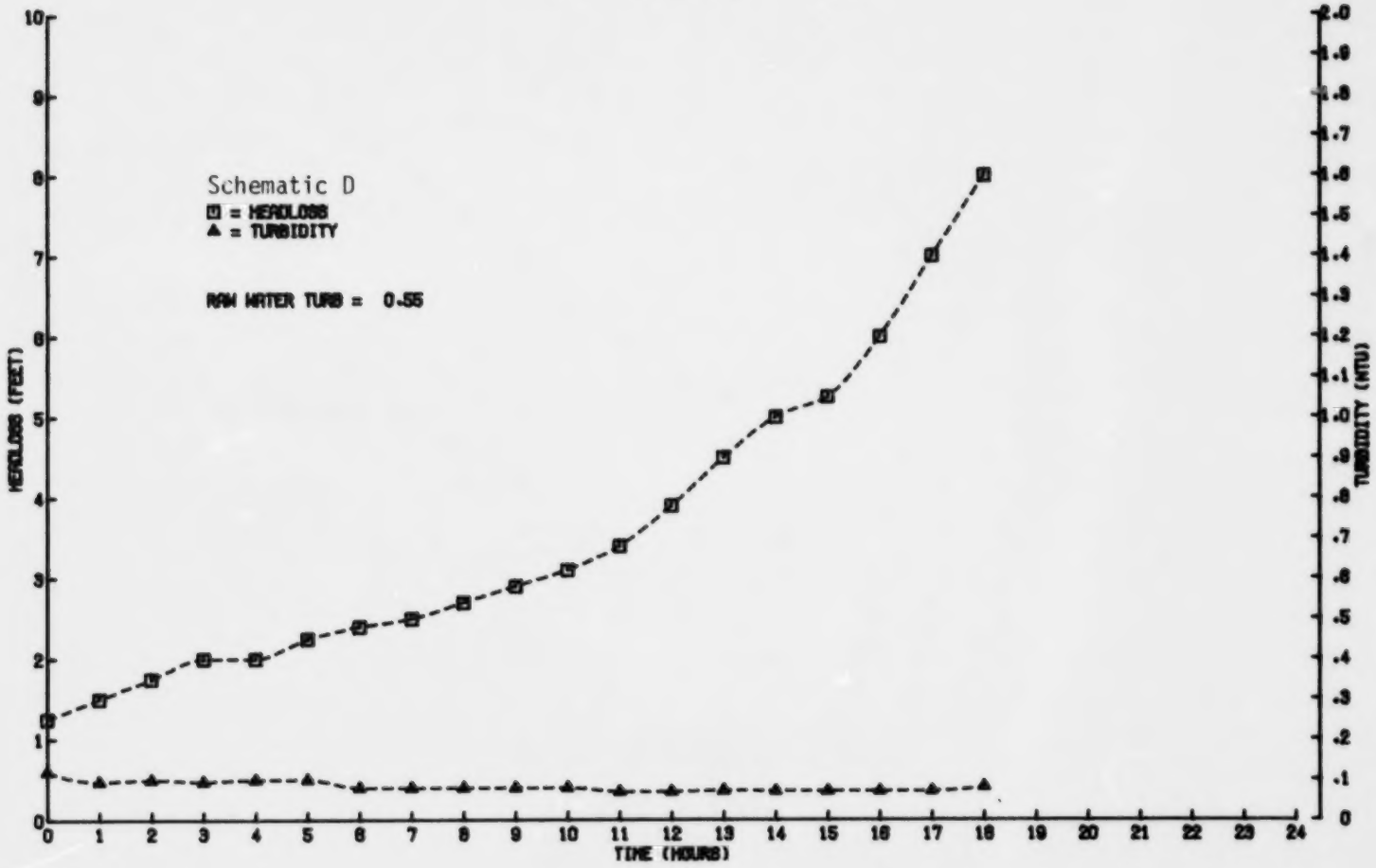
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 107



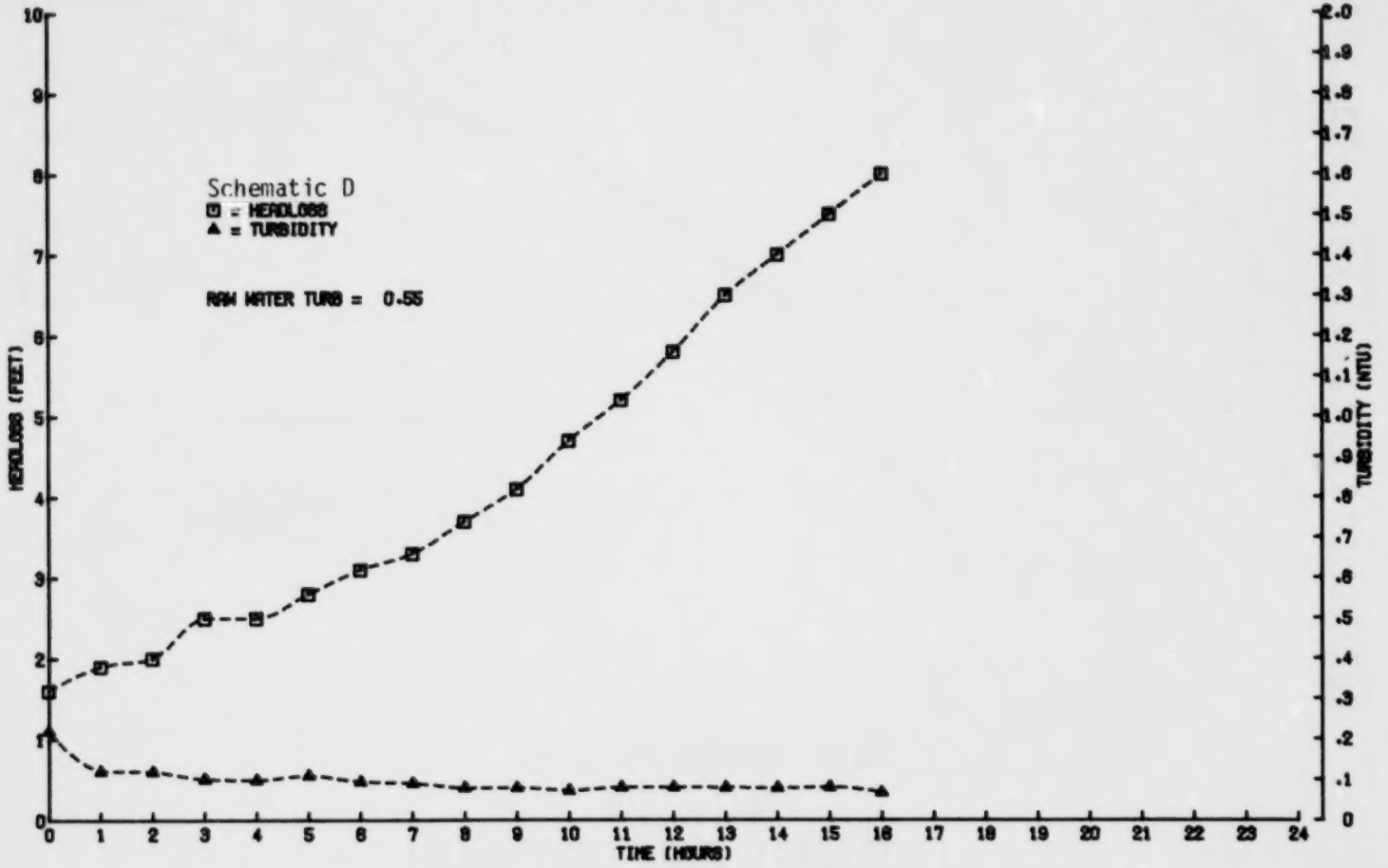
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 107M



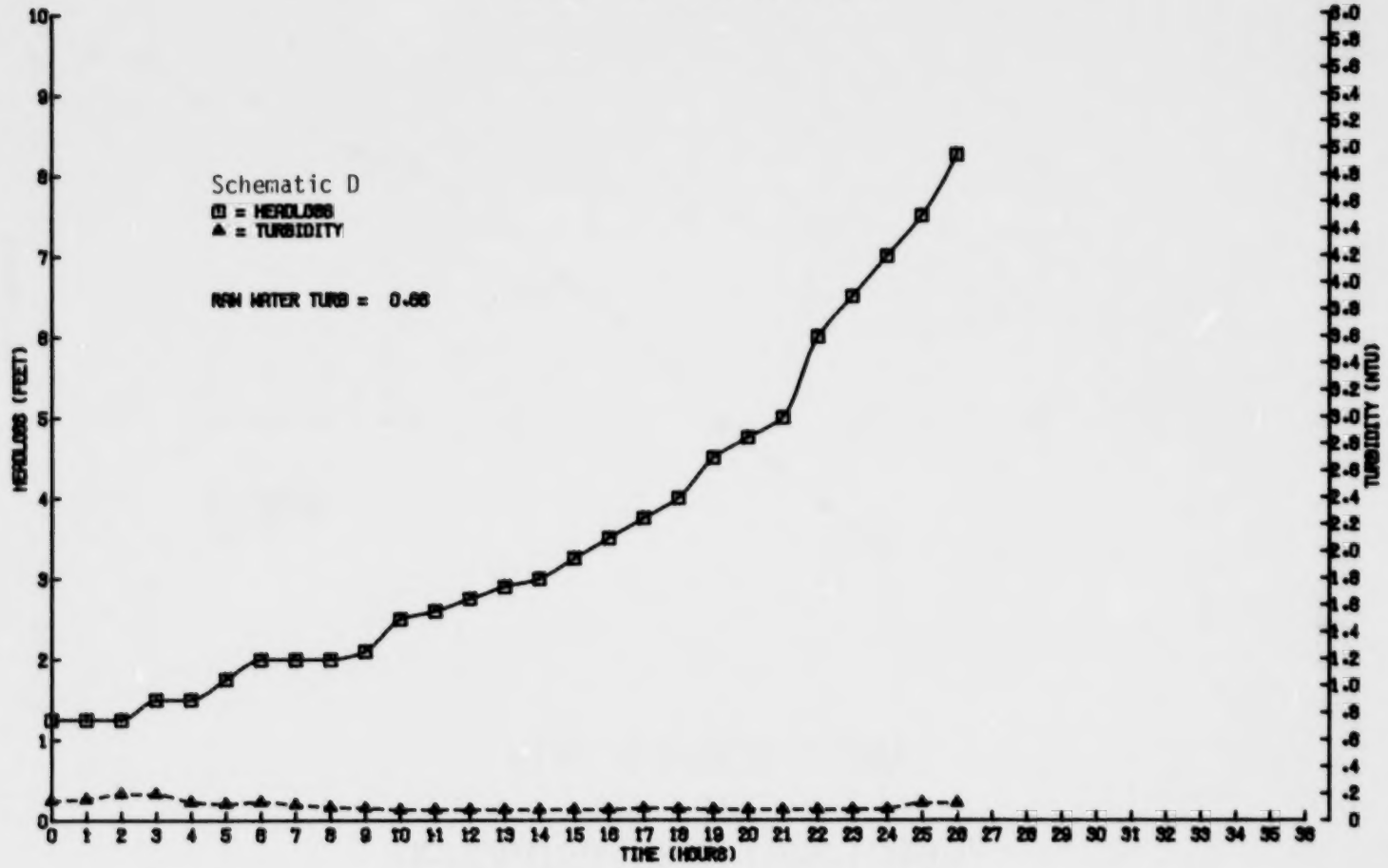
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 108



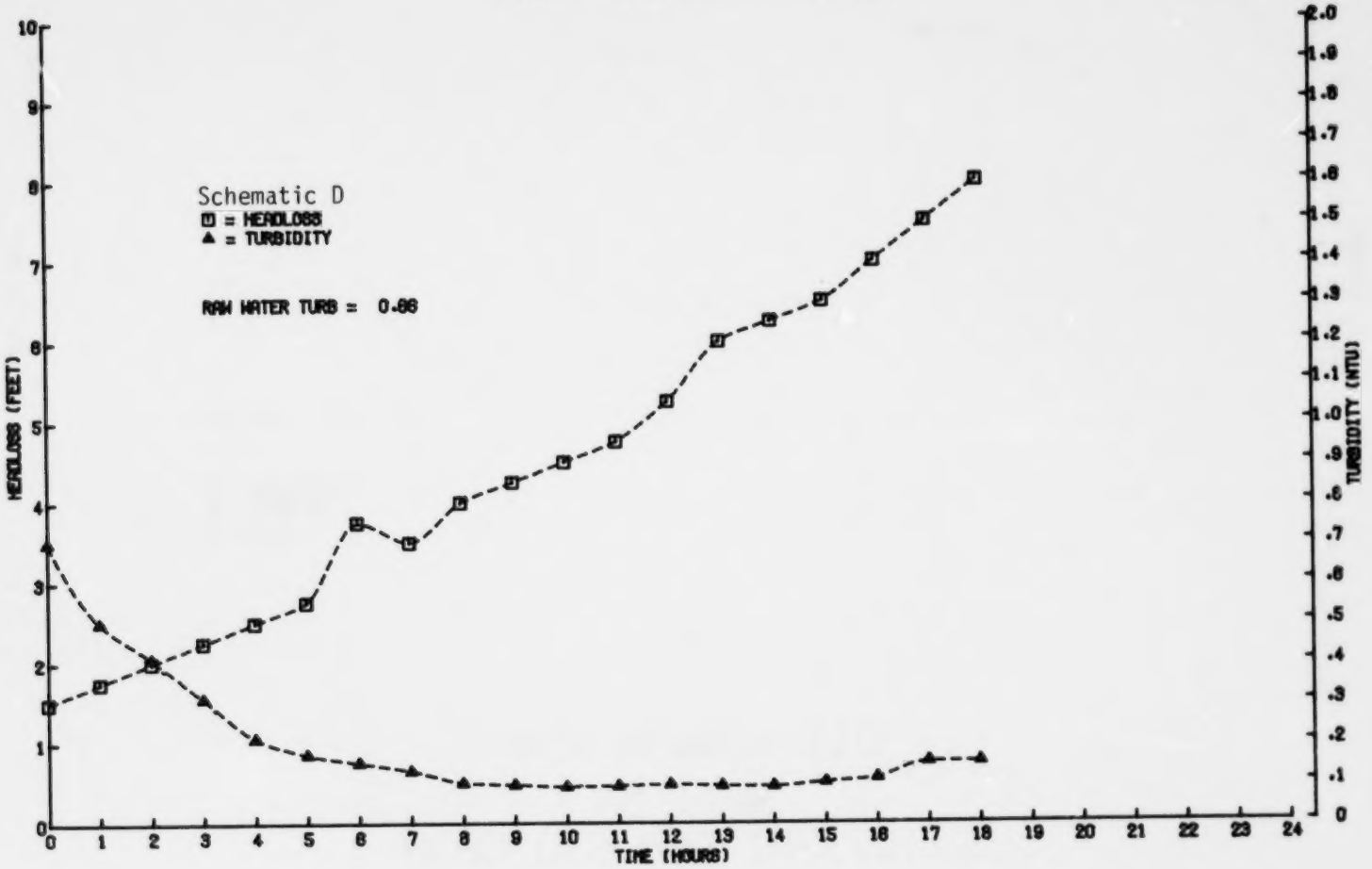
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 108M



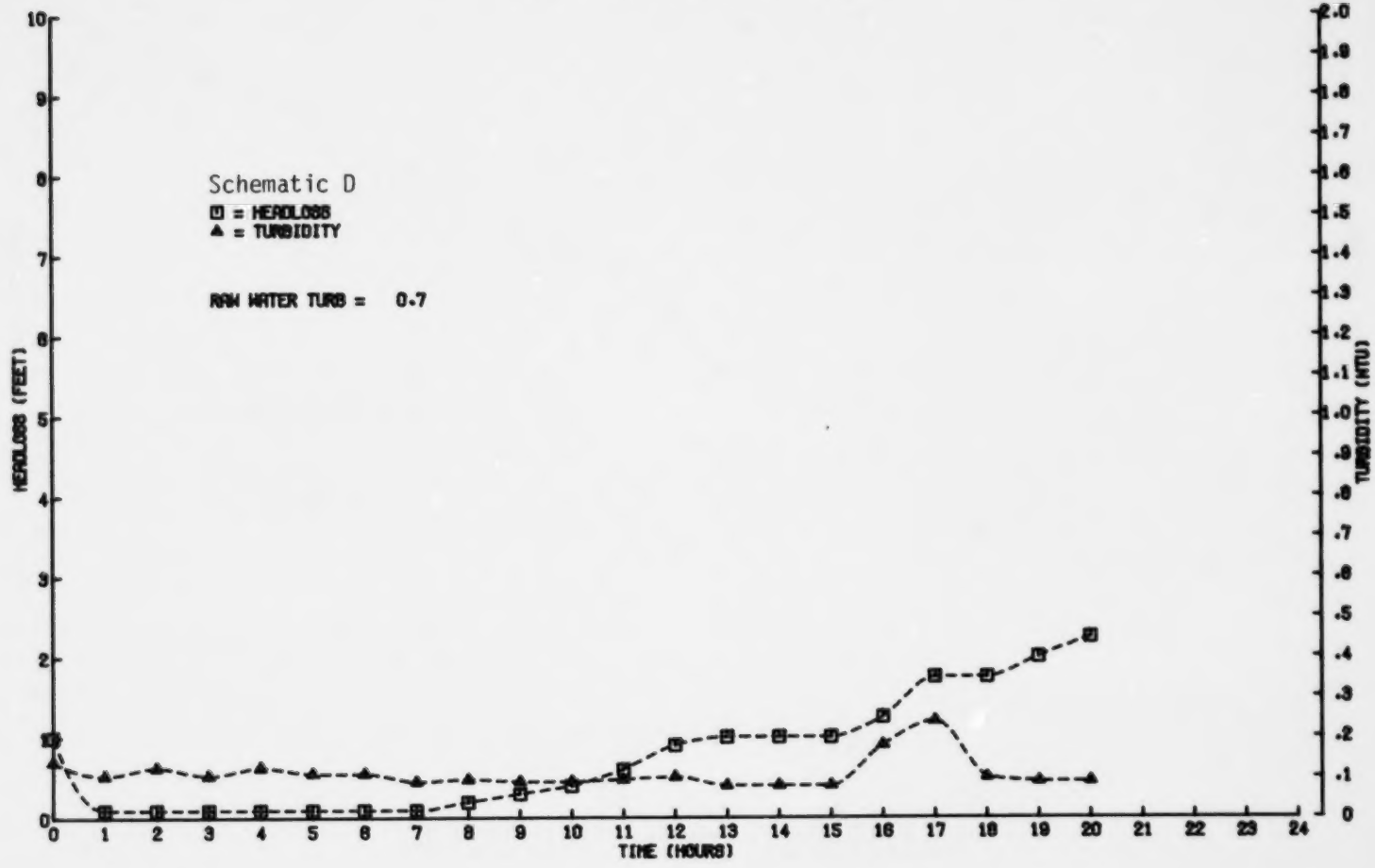
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 109



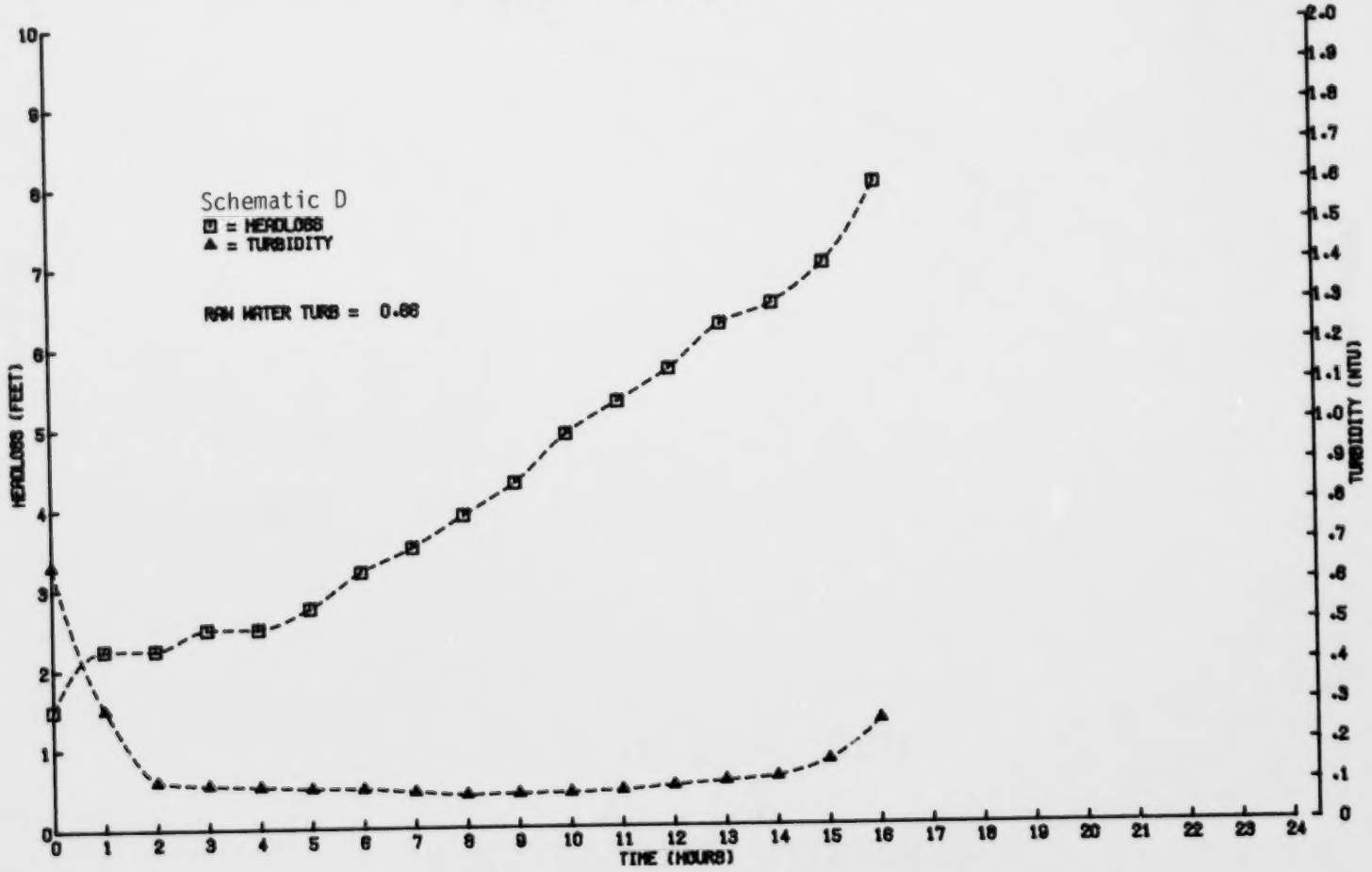
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 109M



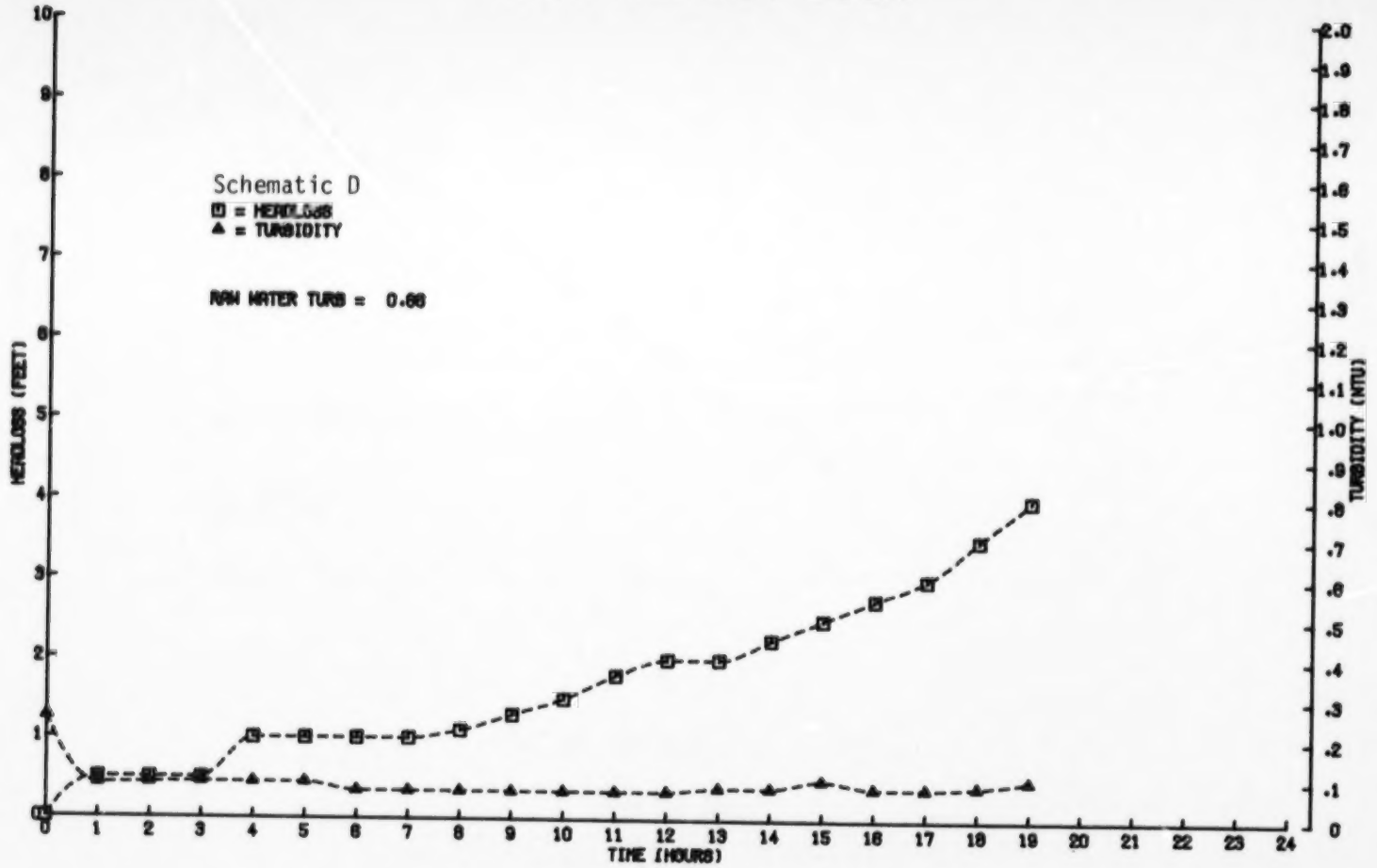
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 110



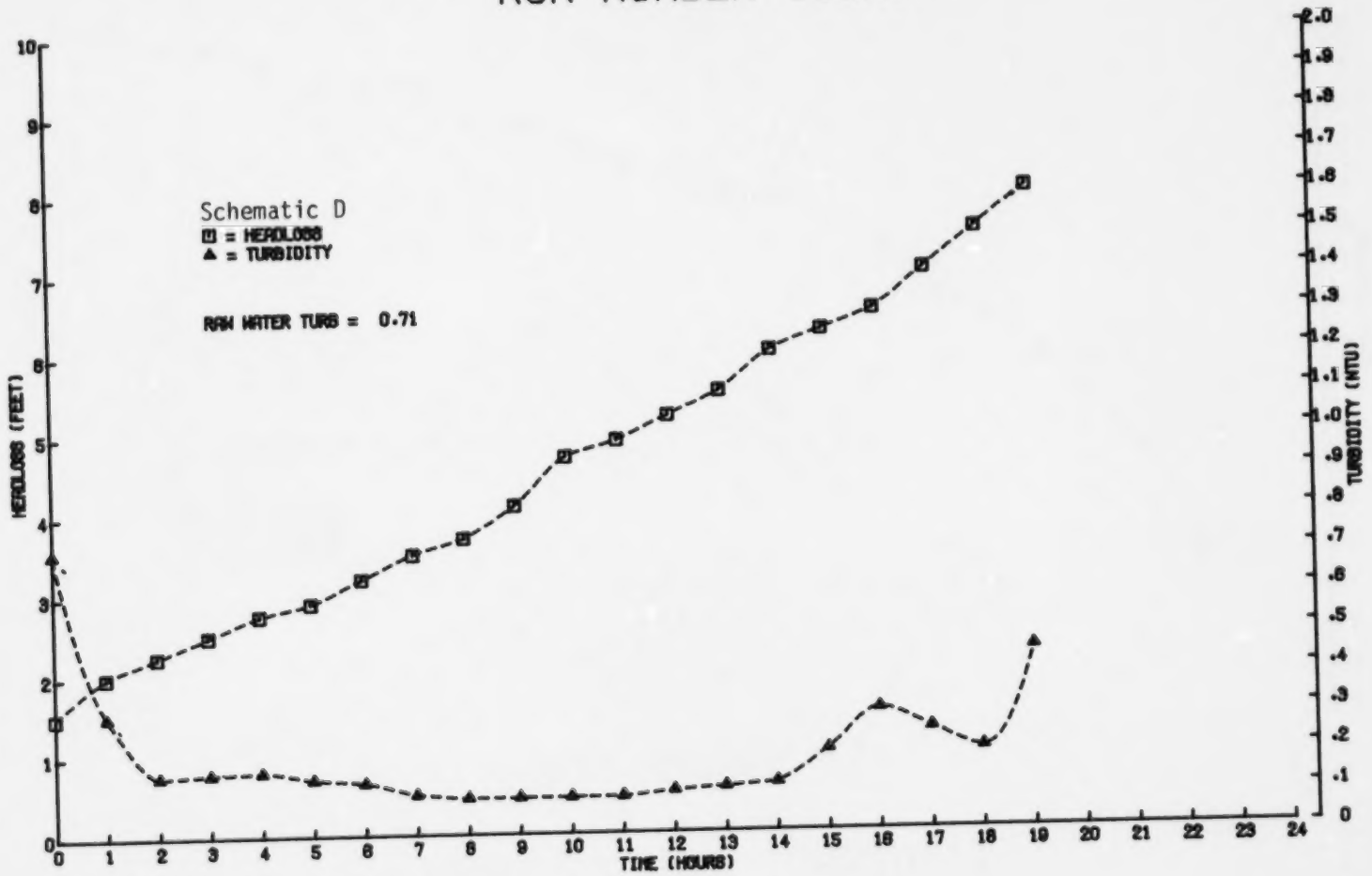
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 110M



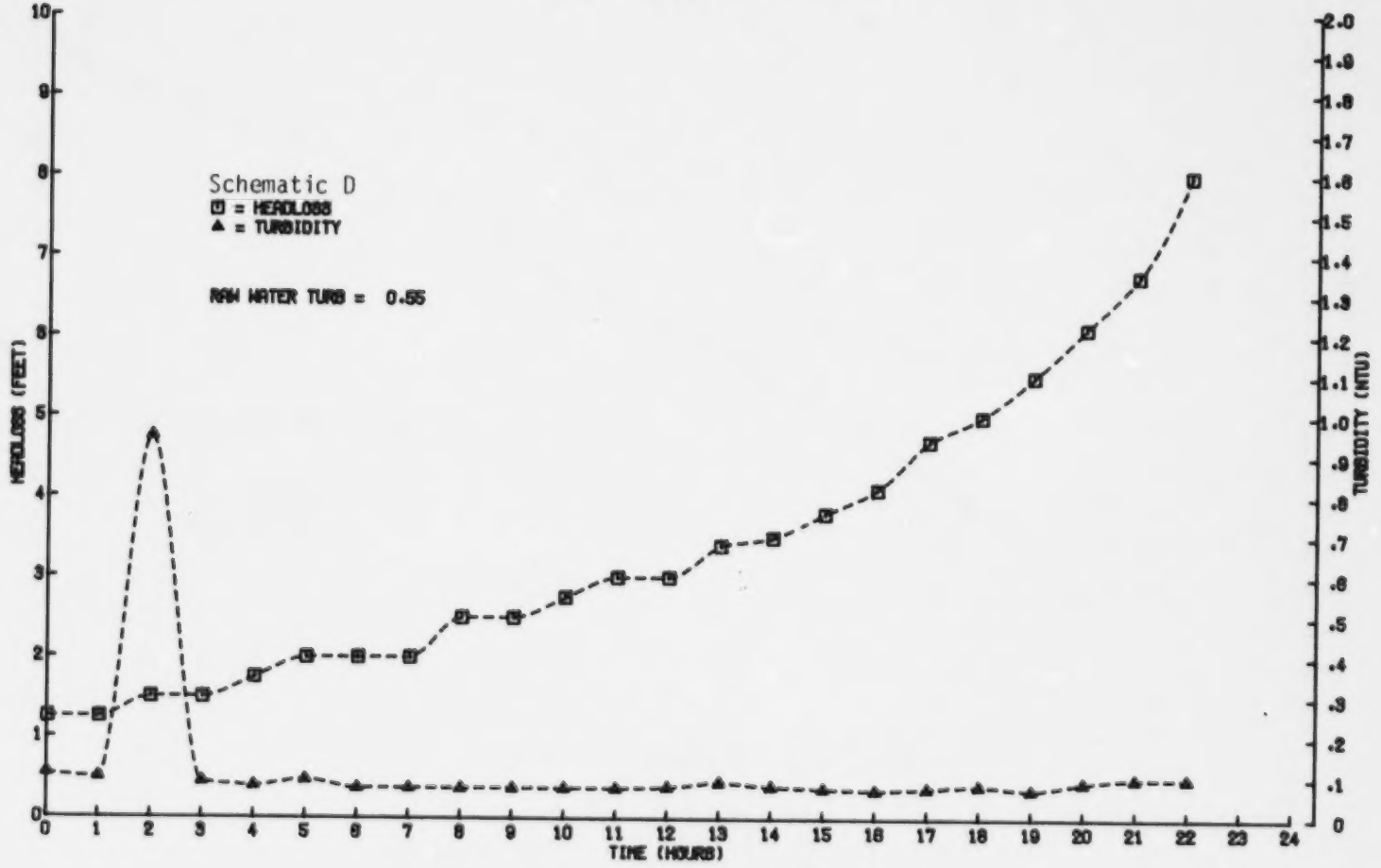
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 110A



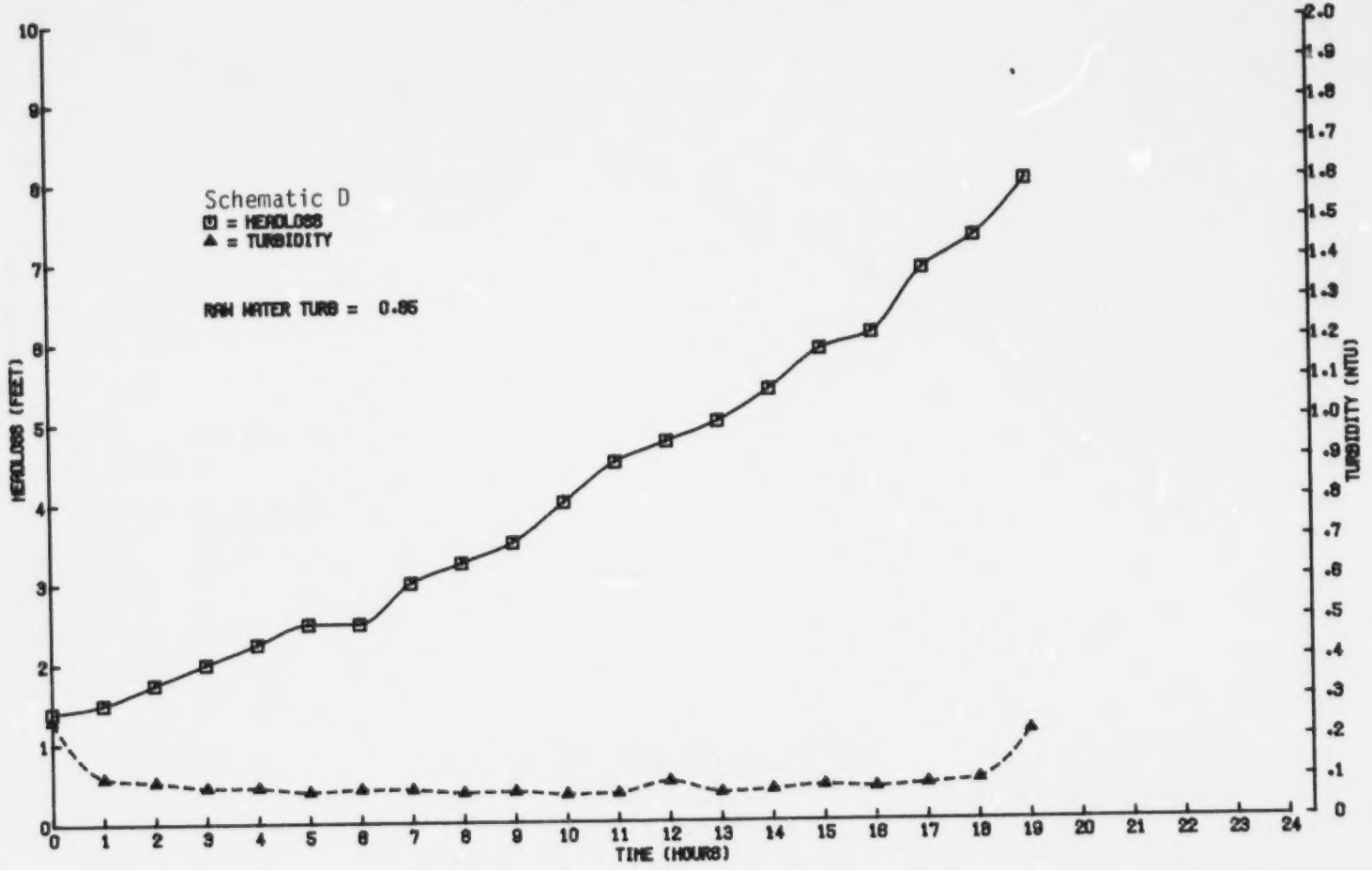
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 110MA



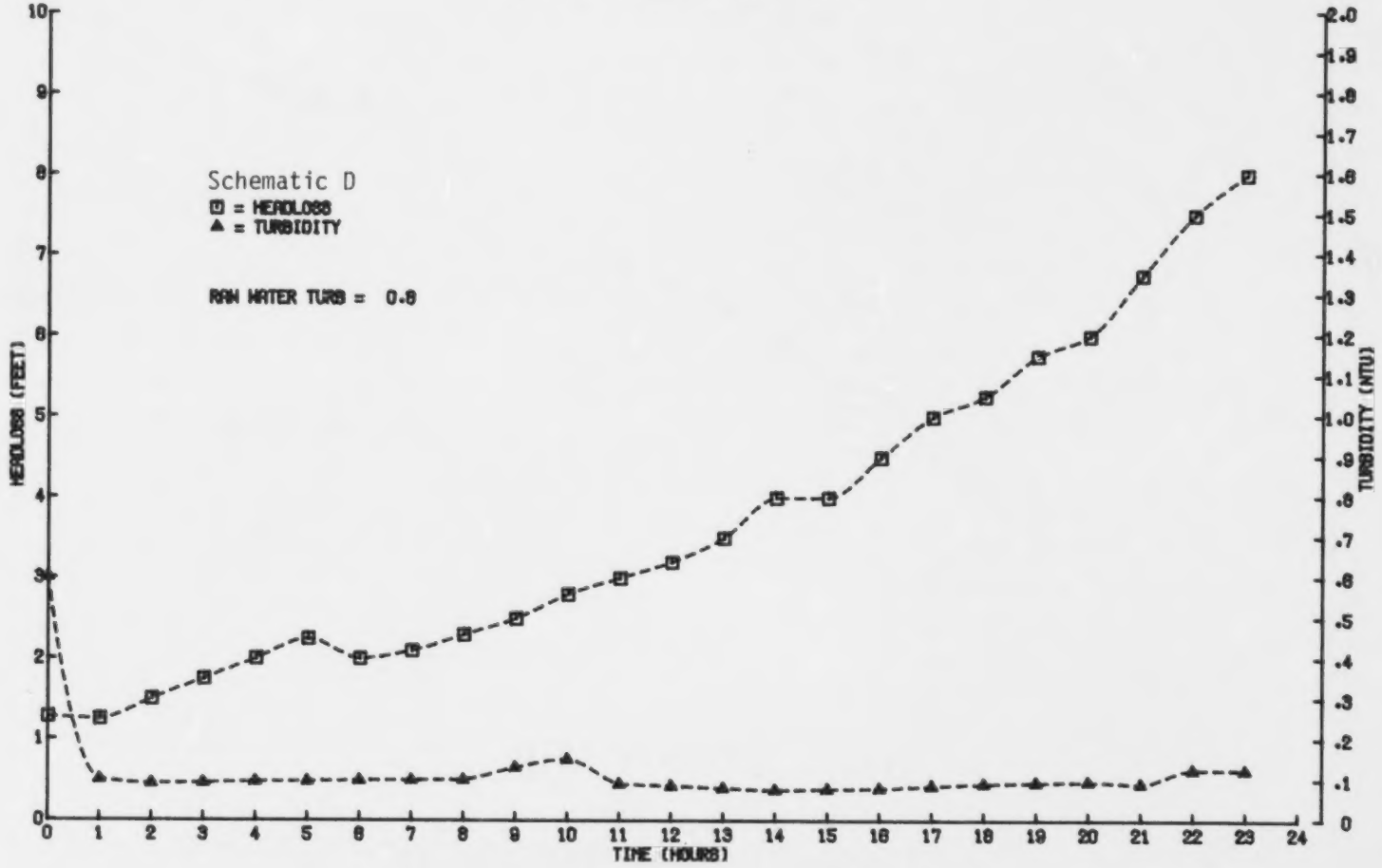
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 111



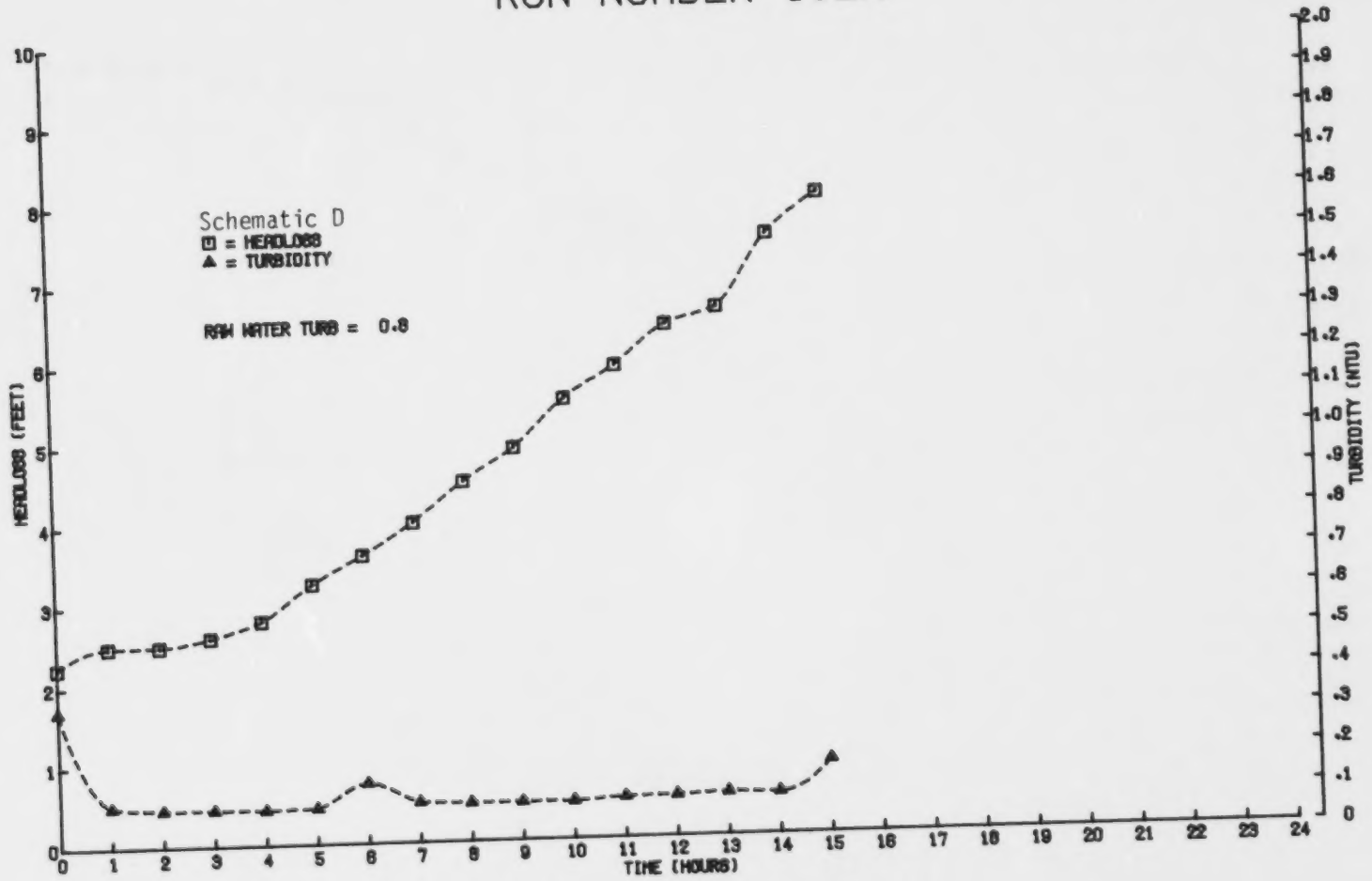
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 111M

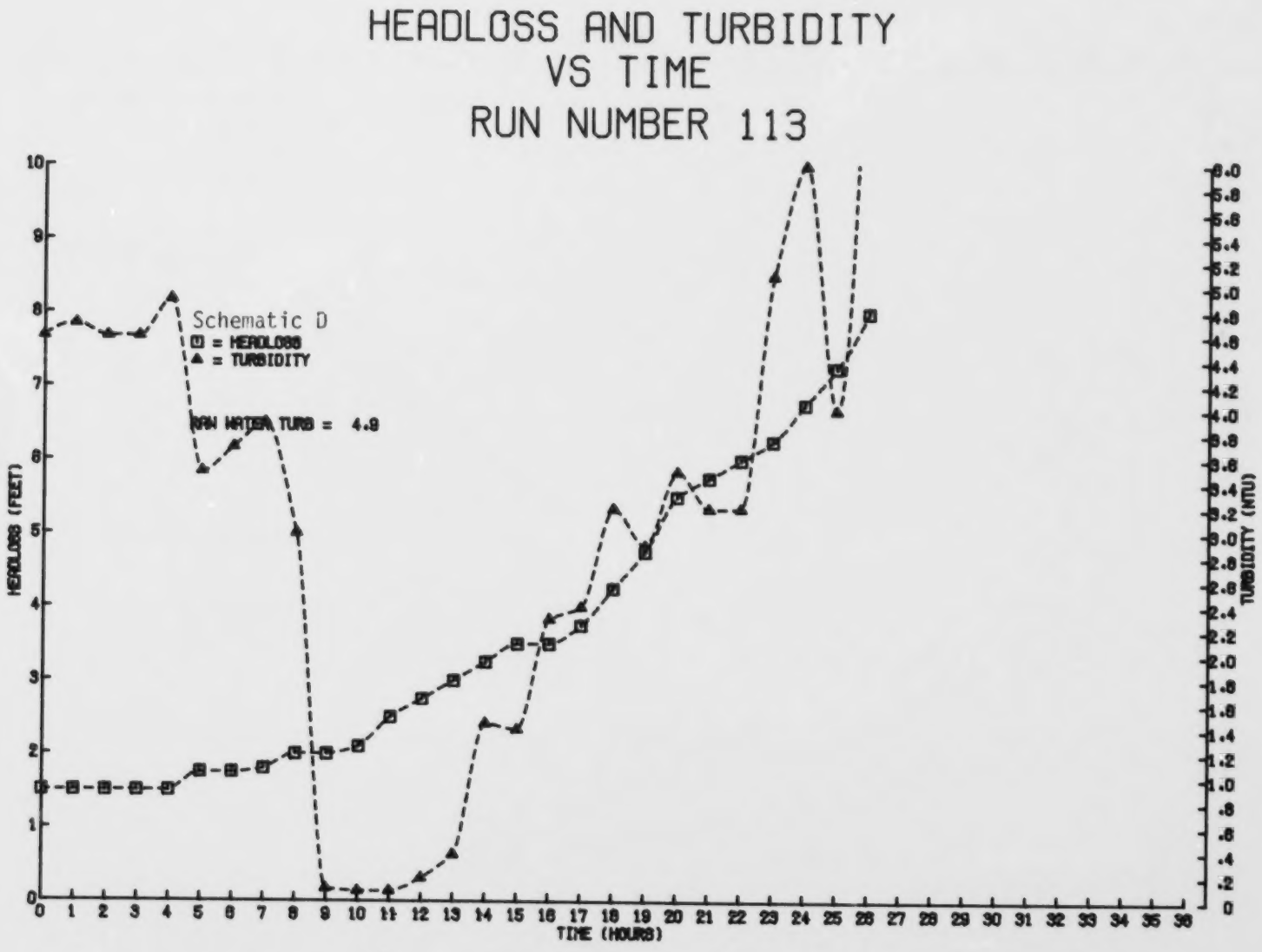


HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 112

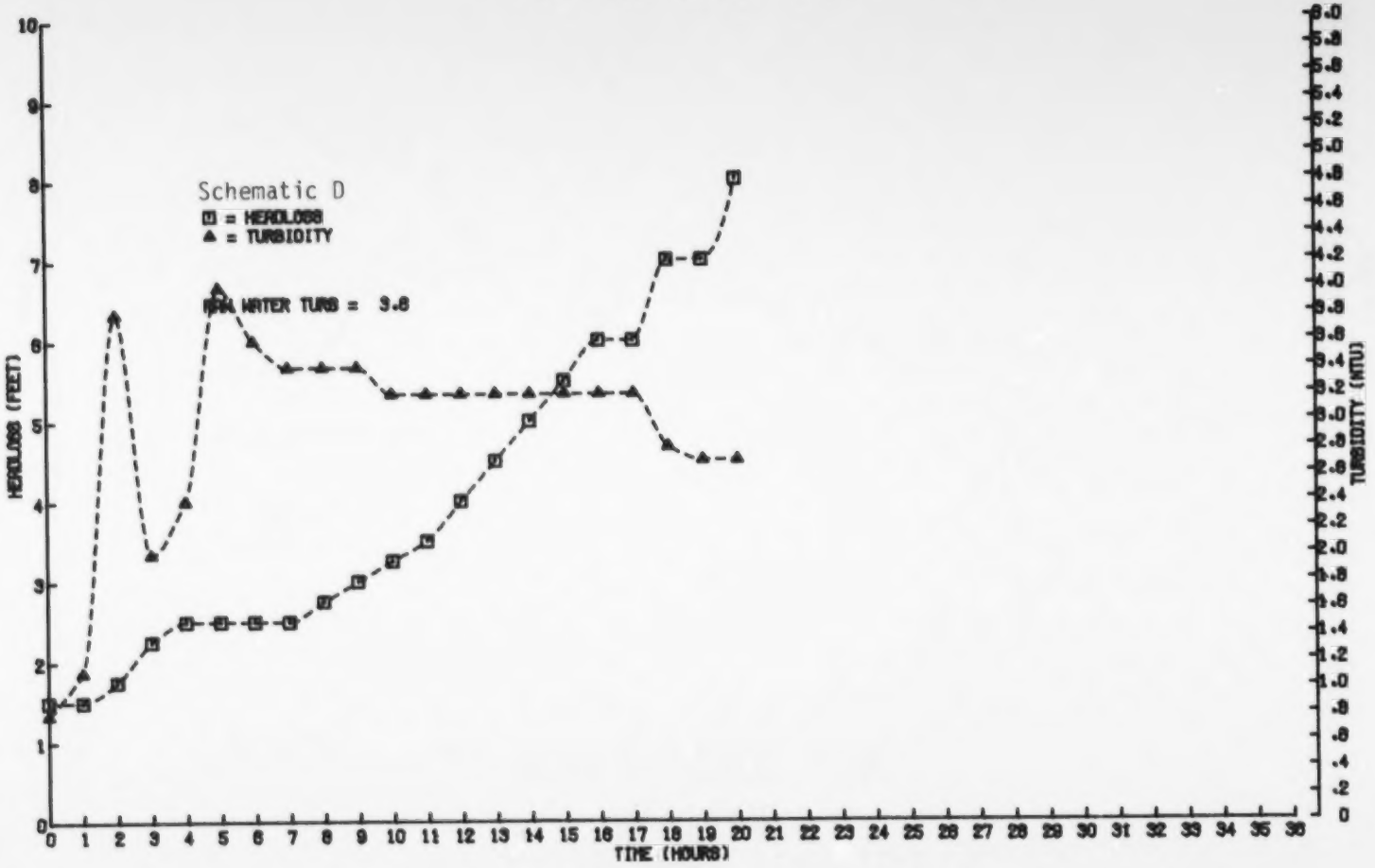


HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 112M

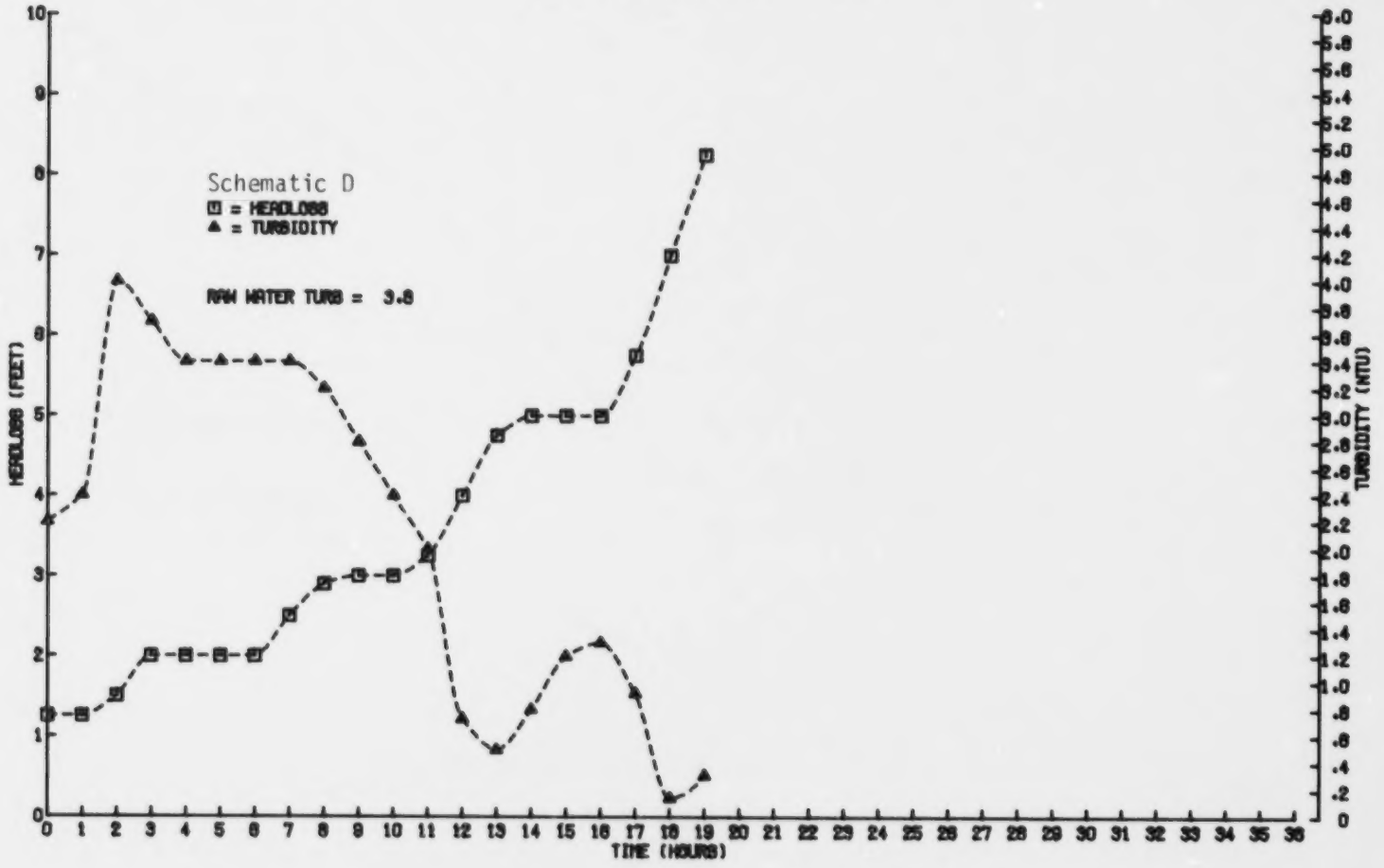



HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 113
Schematic D
= HEADLOSS
= TURBIDITY
RAW WATER TURB = 4.9
HEADLOSS (FEET)
TURBIDITY (NTU)
TIME (HOURS)

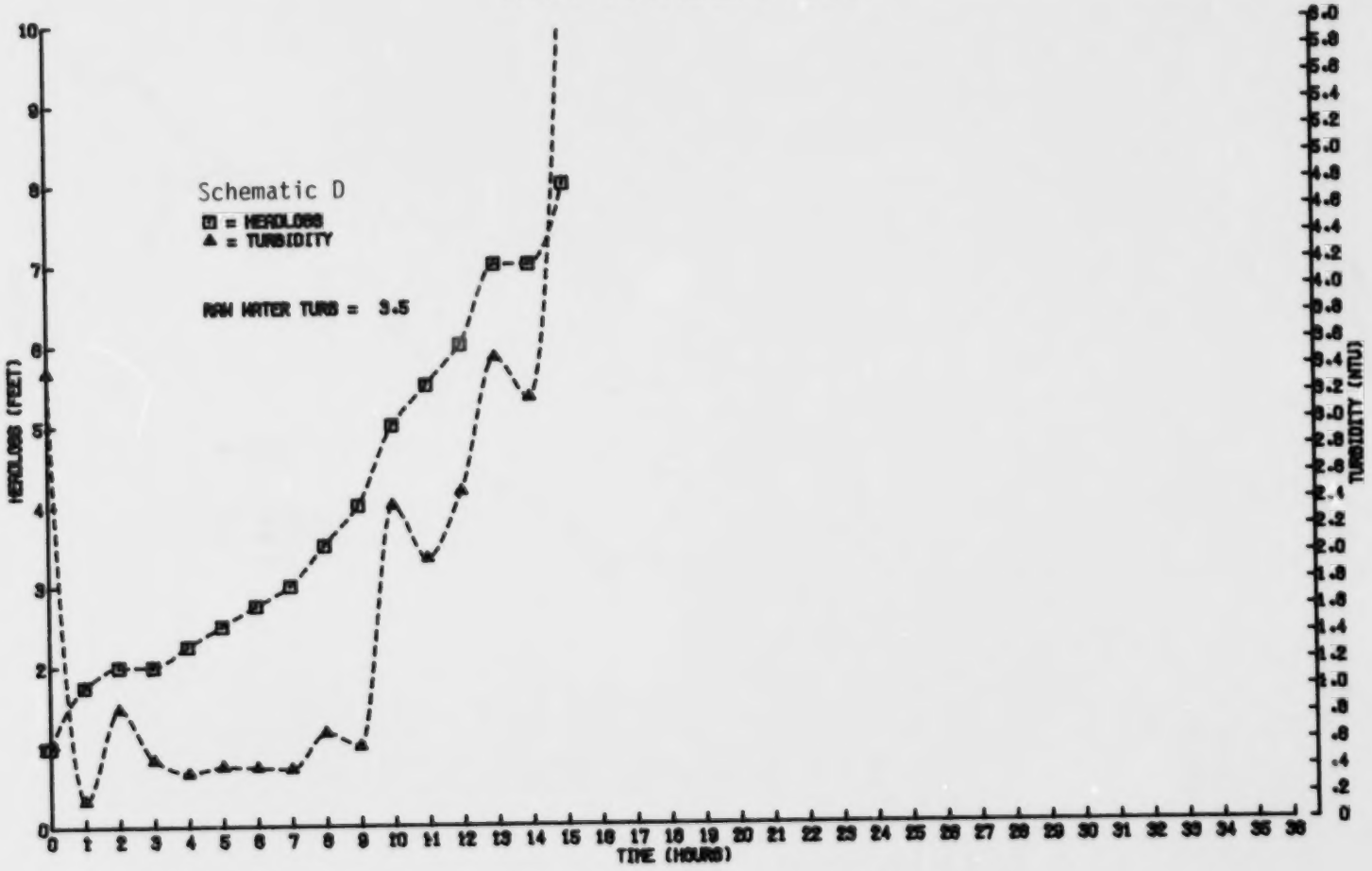
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 114



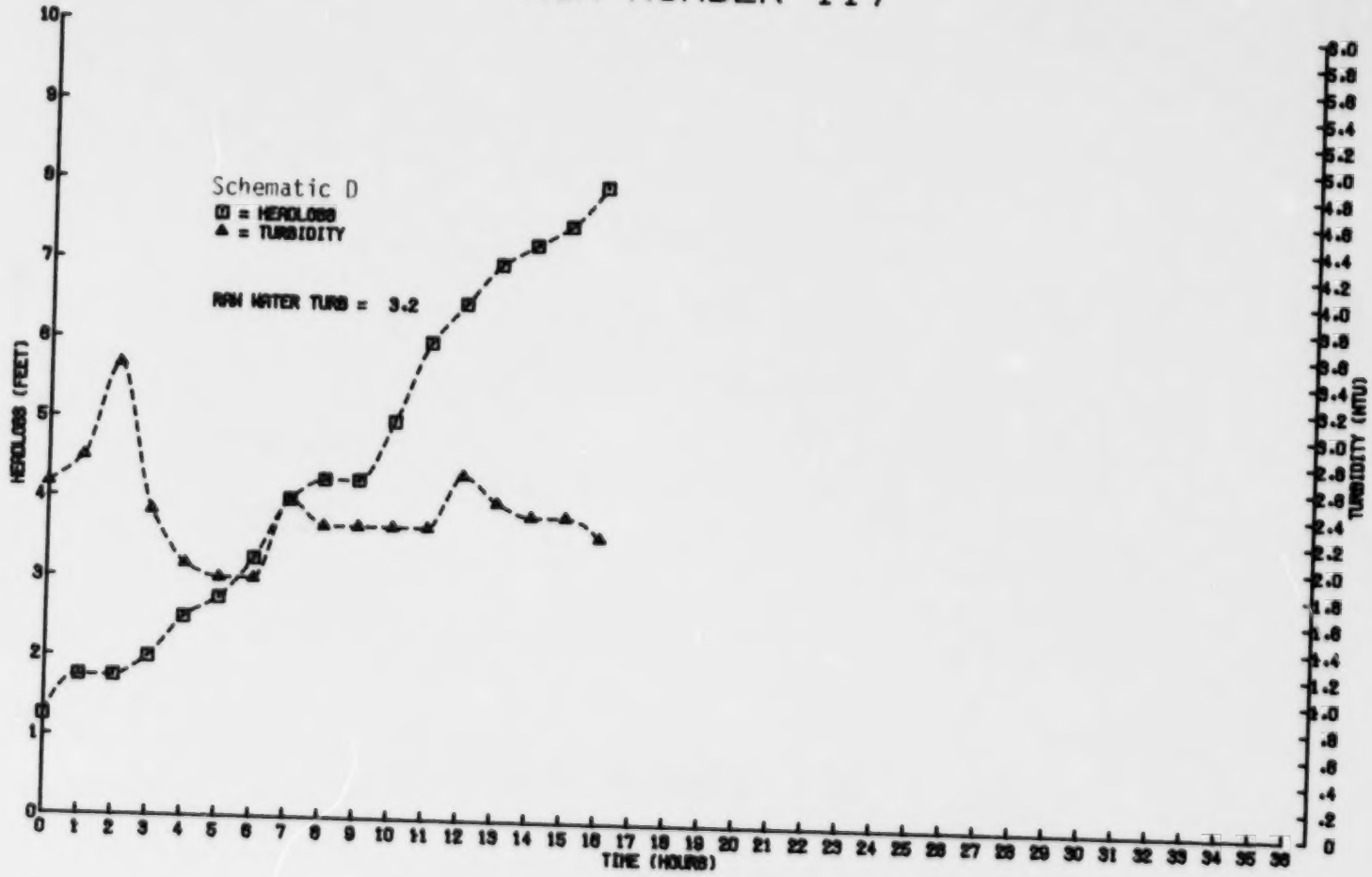
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 115



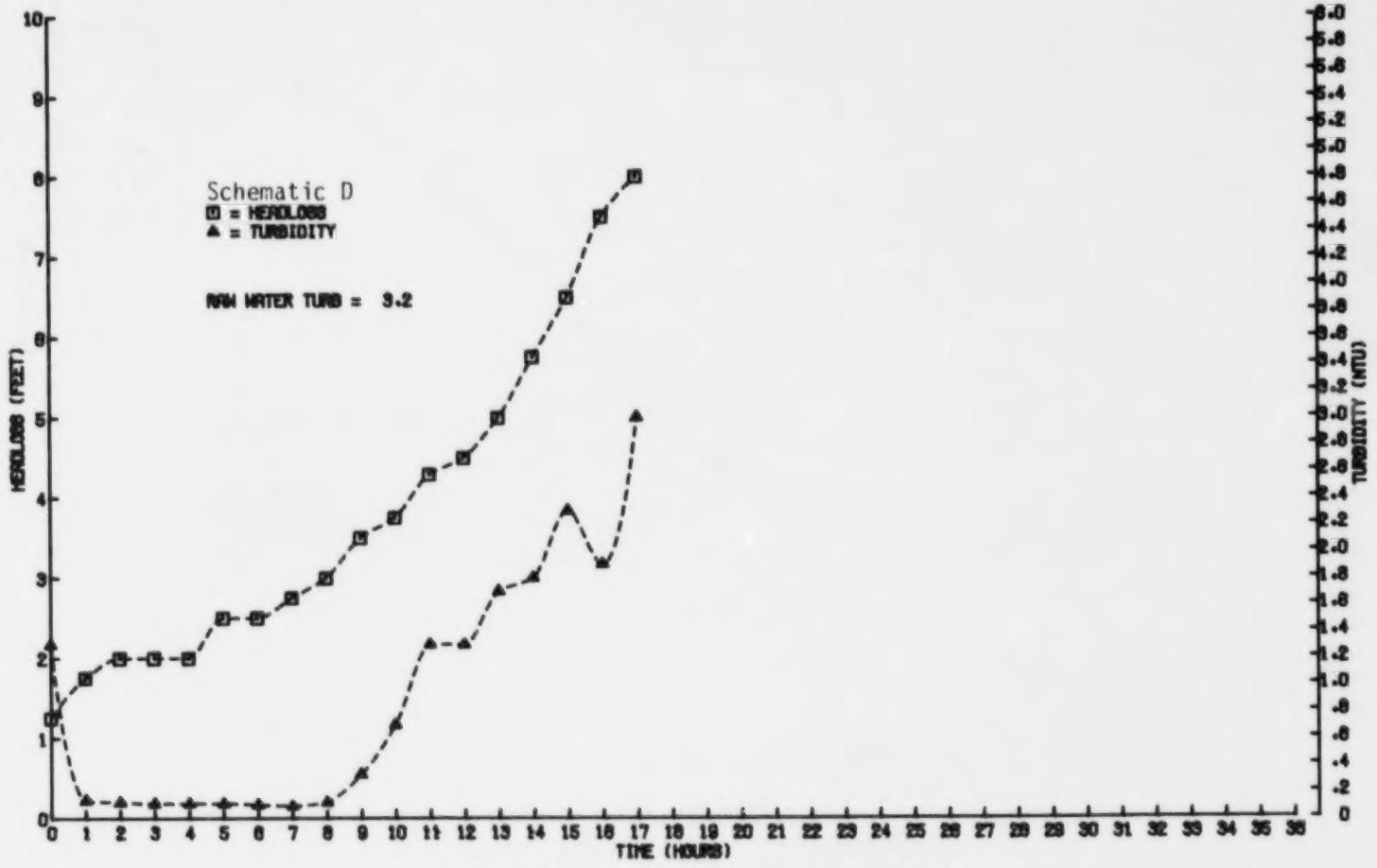
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 116



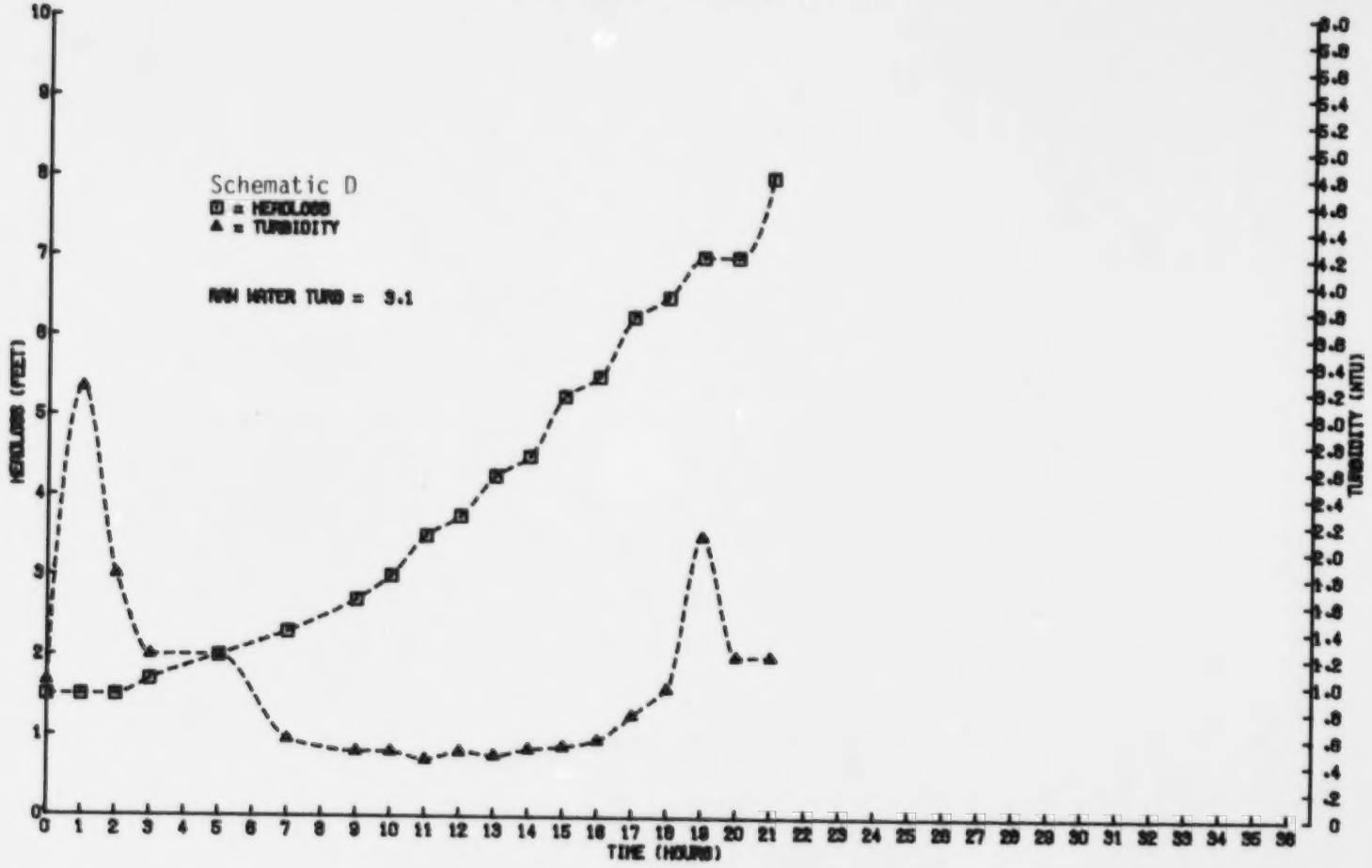
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 117



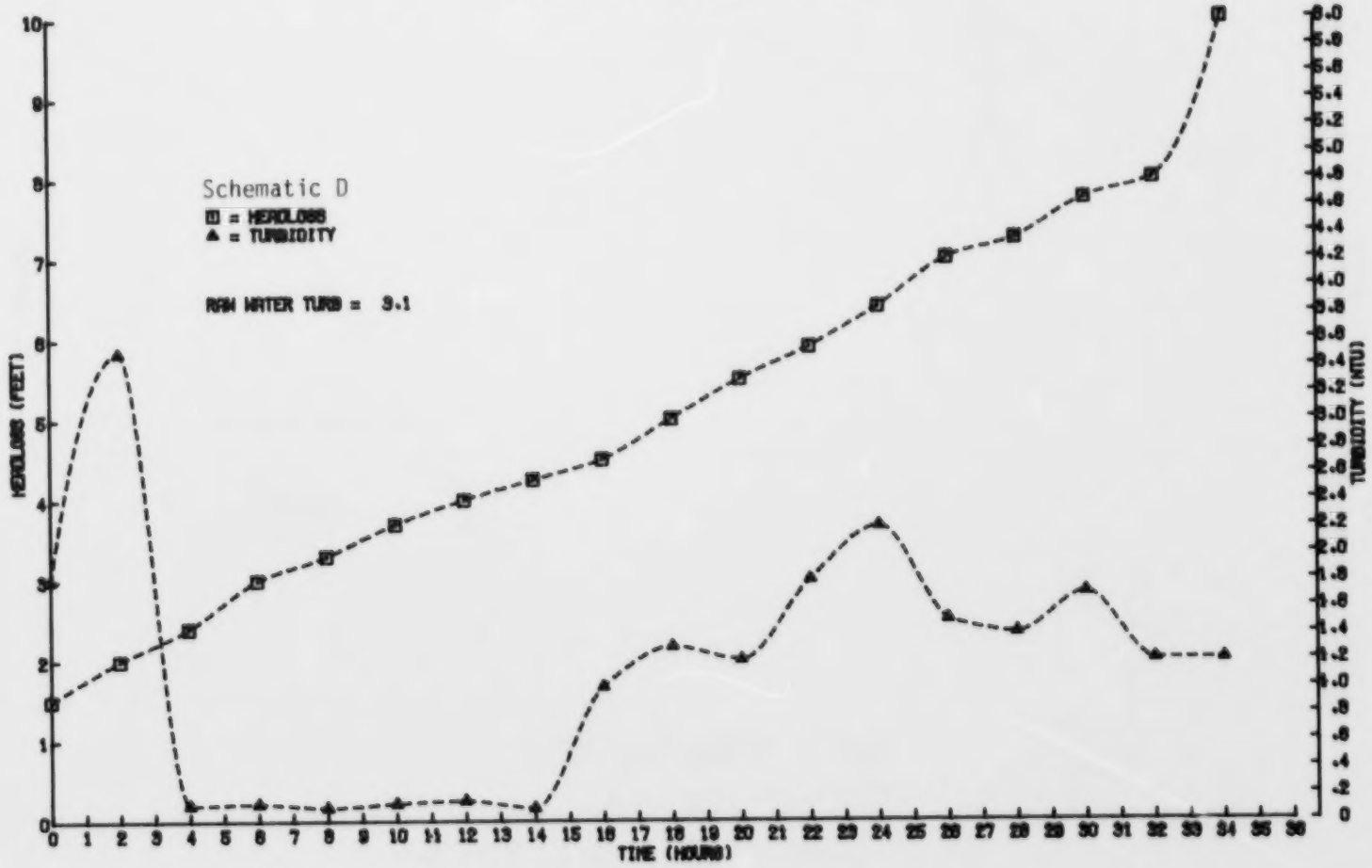
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 118



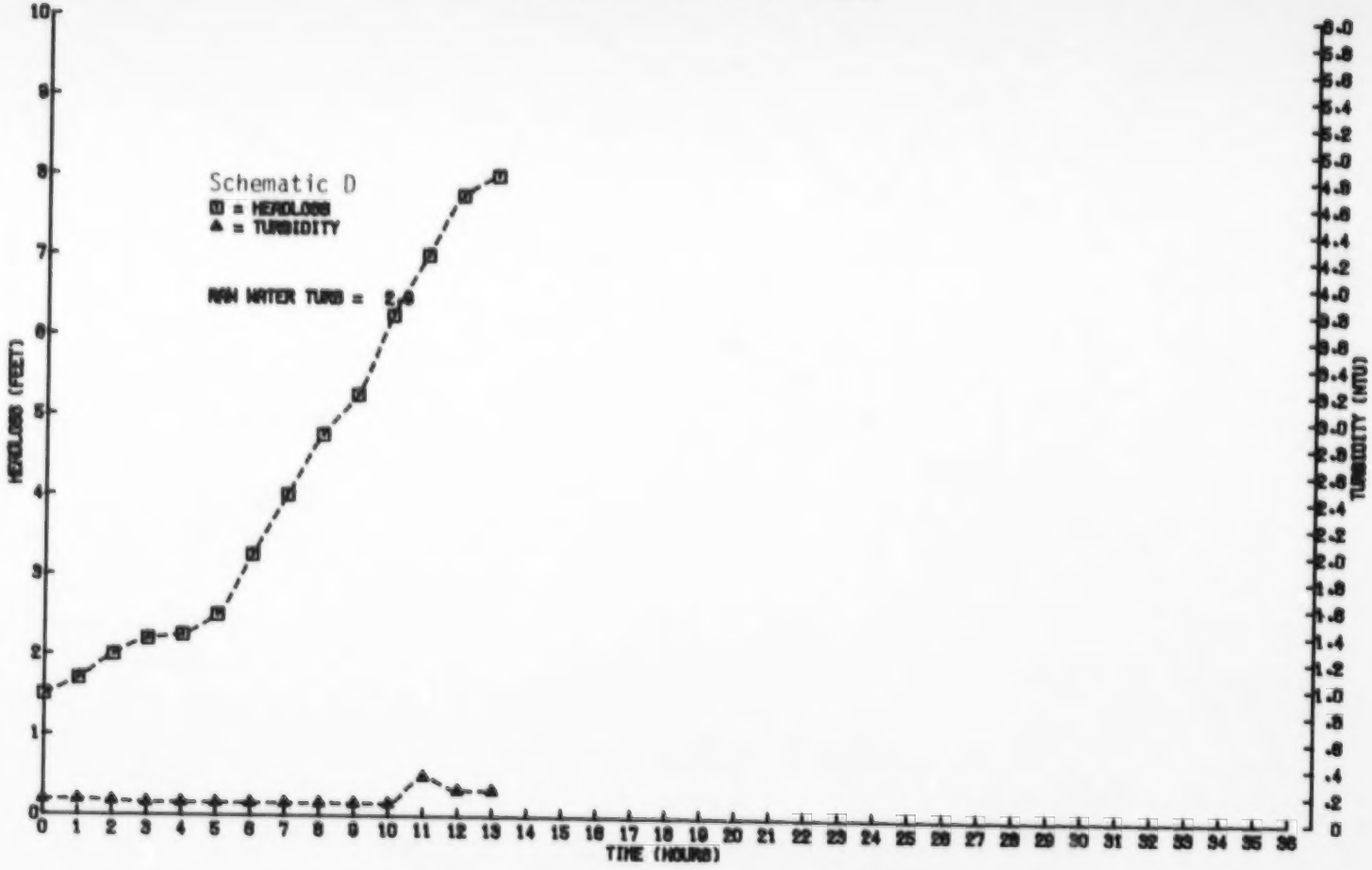
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 119



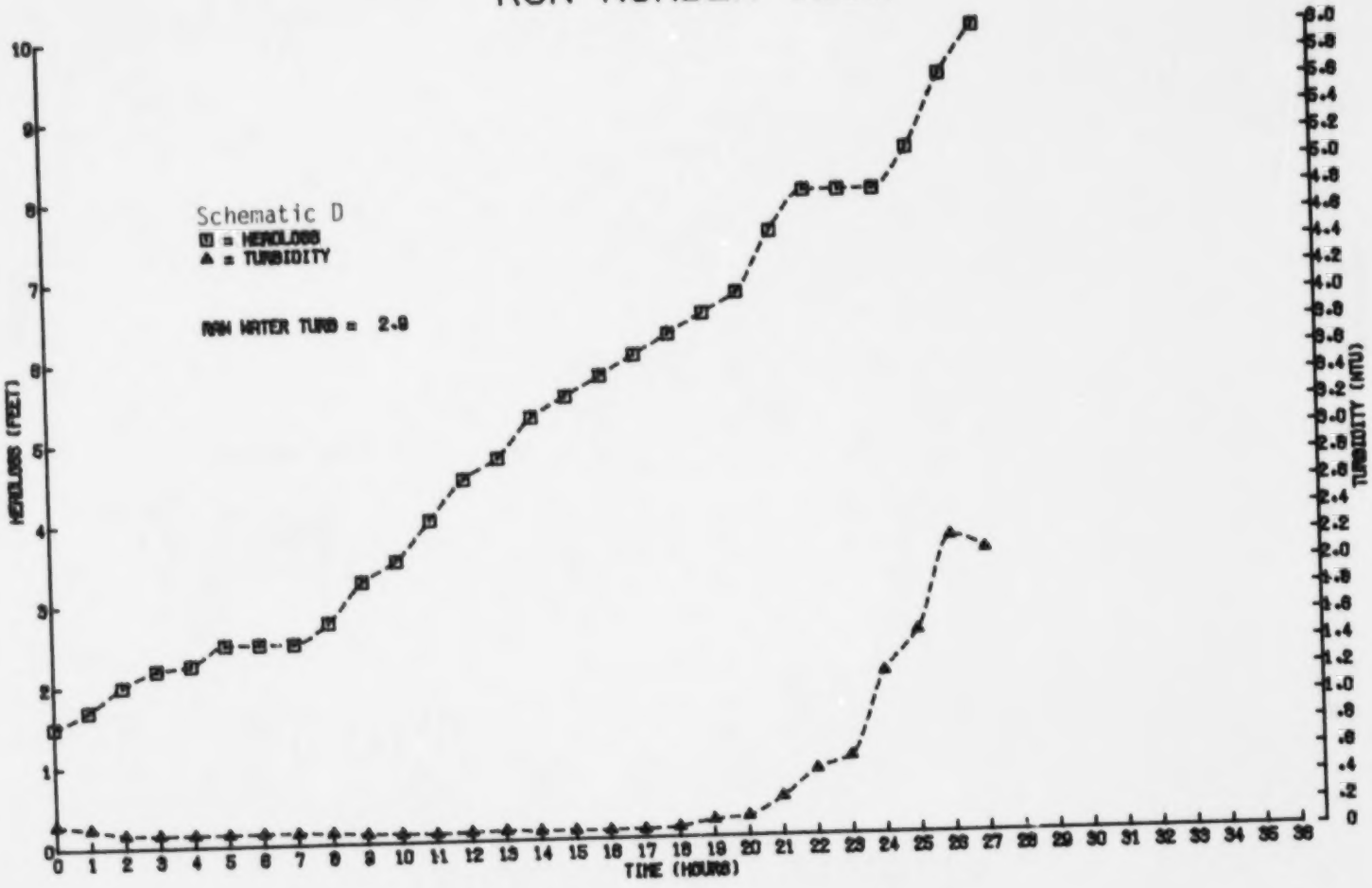
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 119M



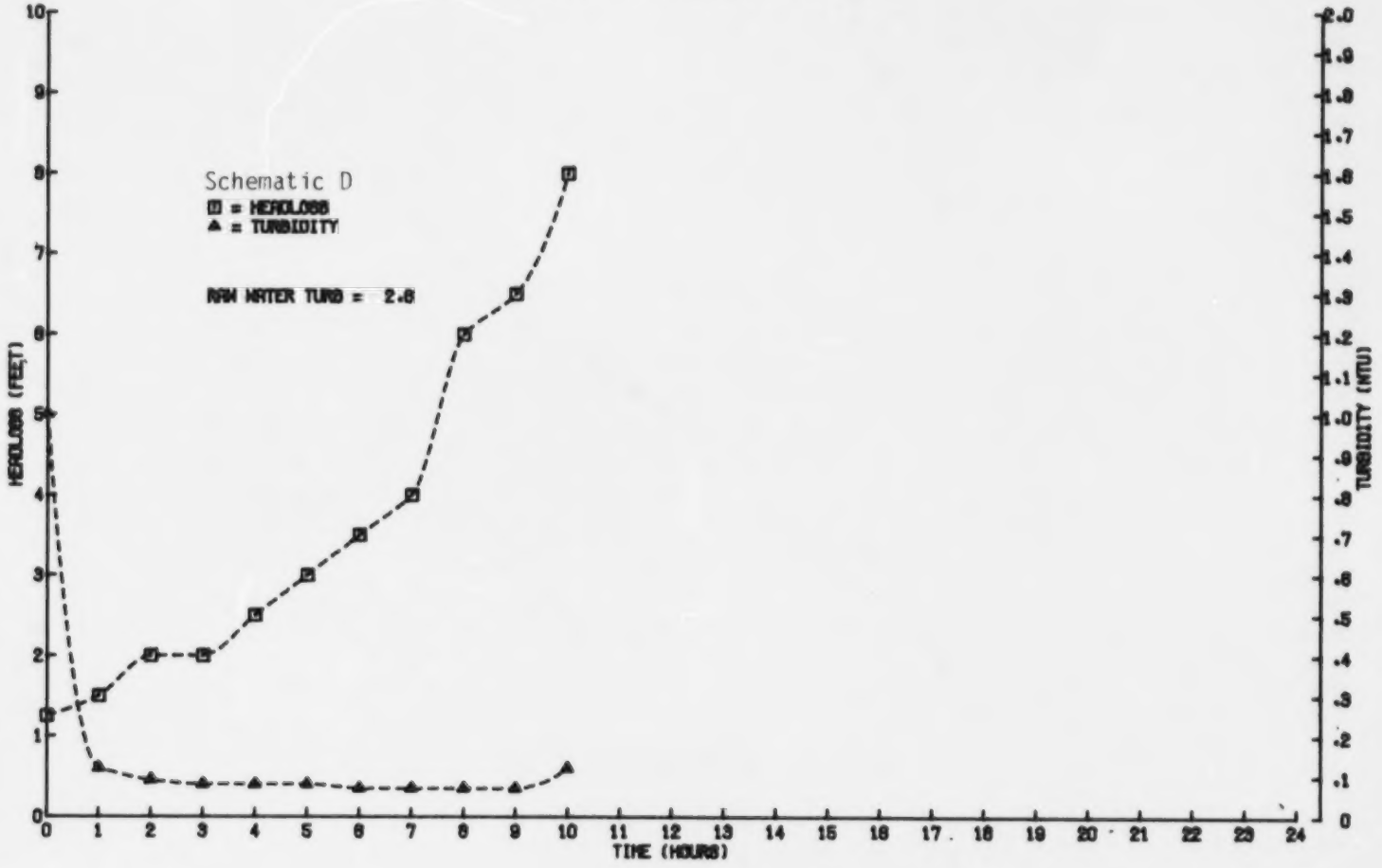
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 120



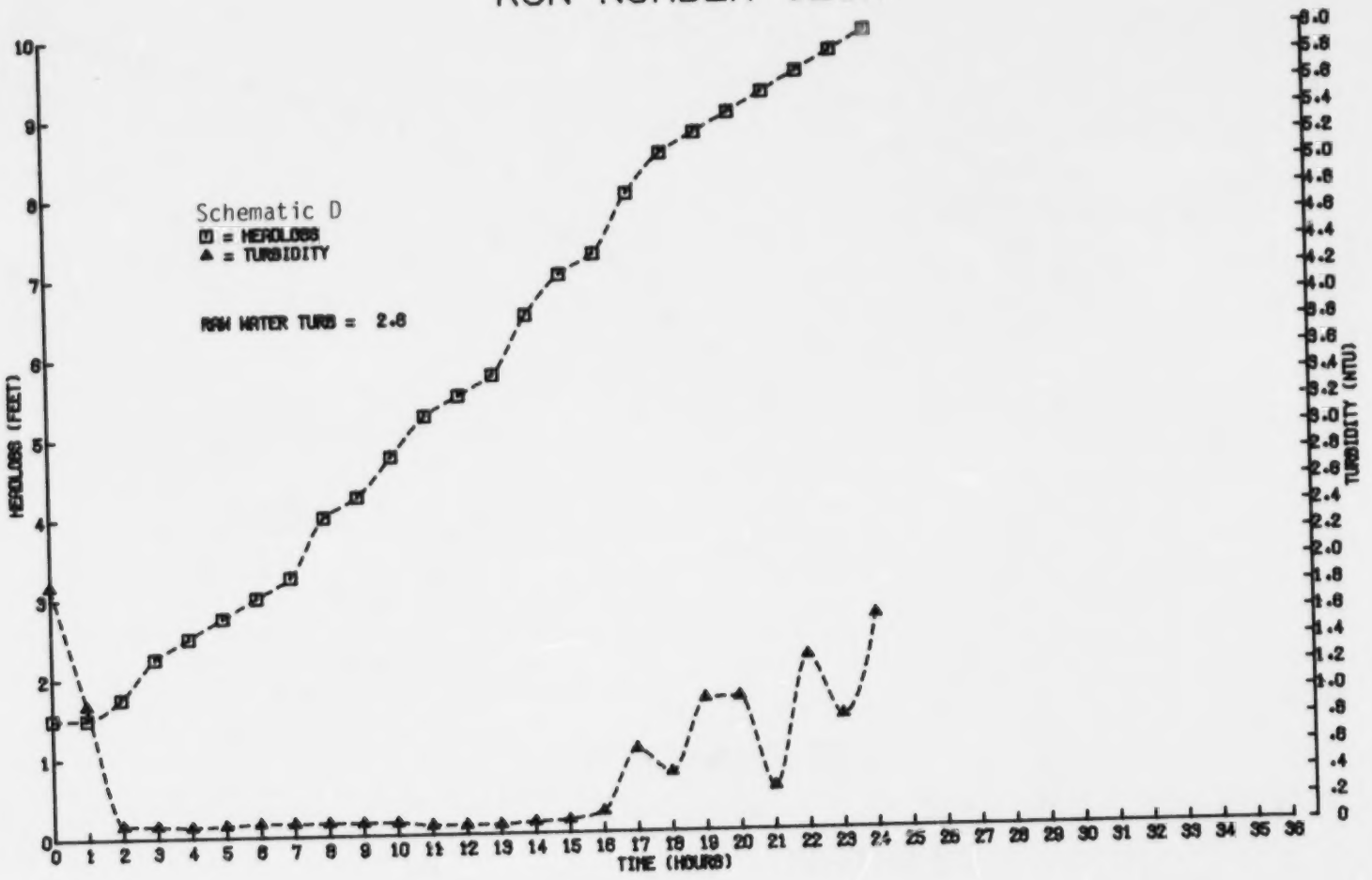
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 120M



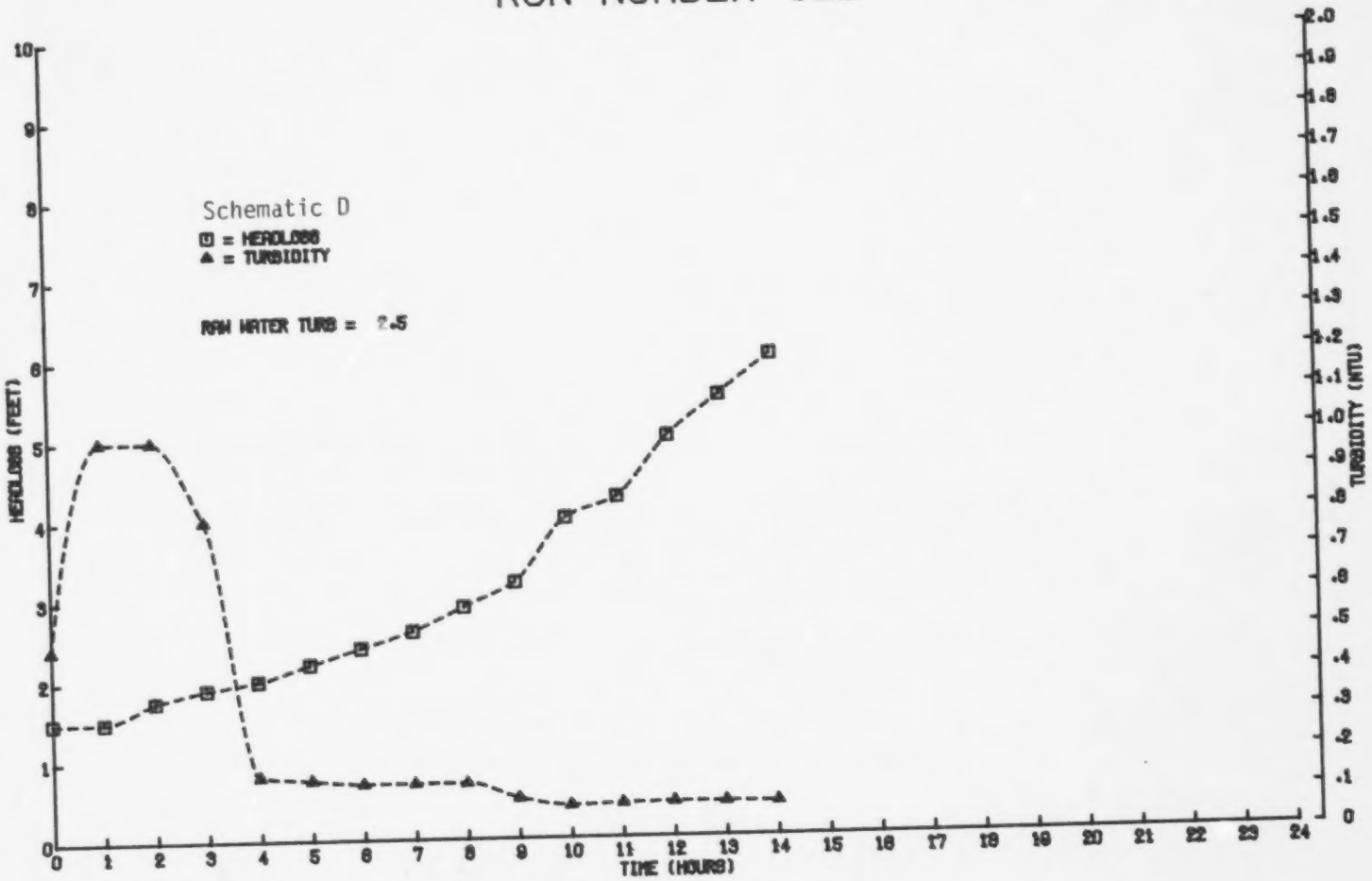
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 121



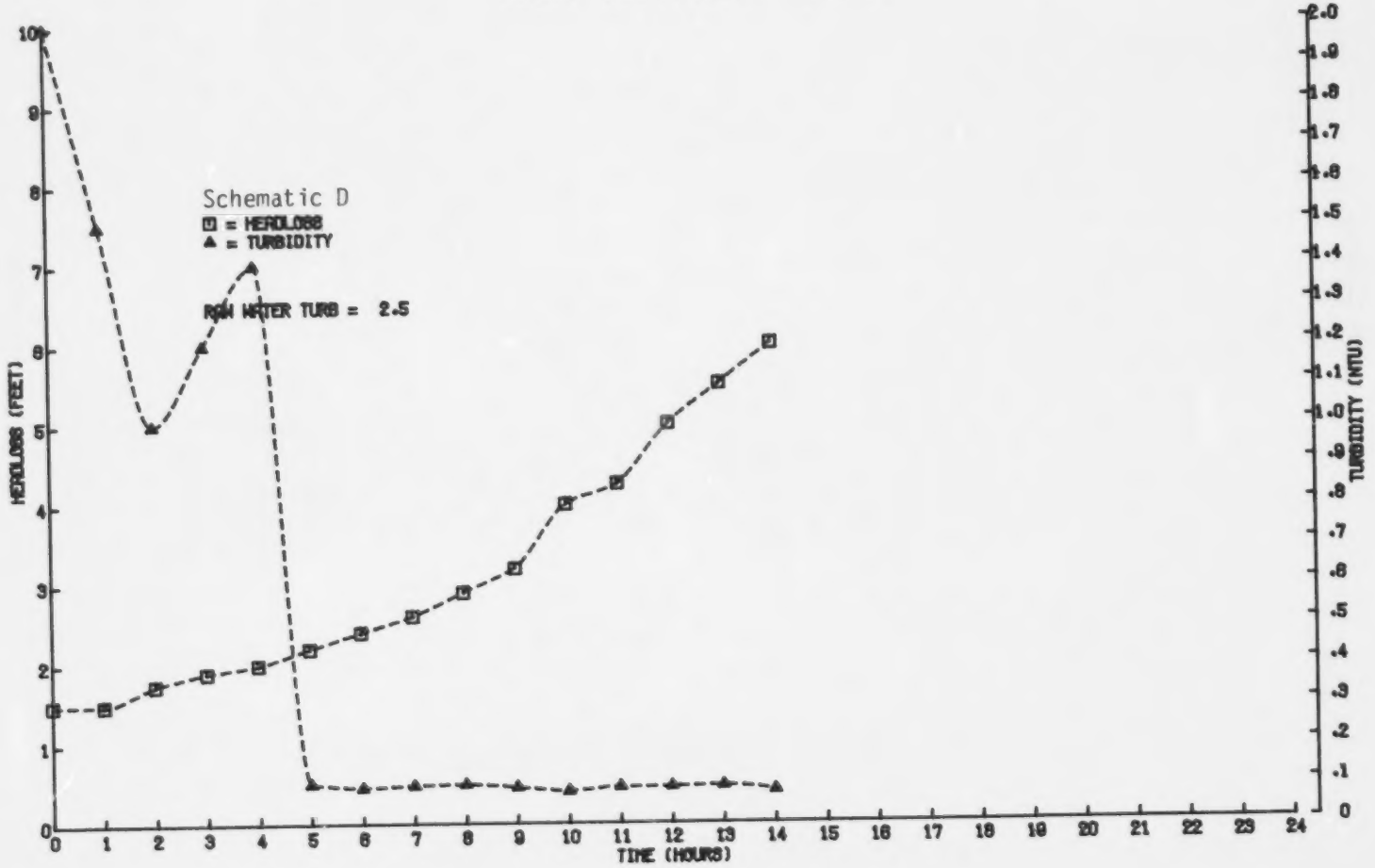
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 121M



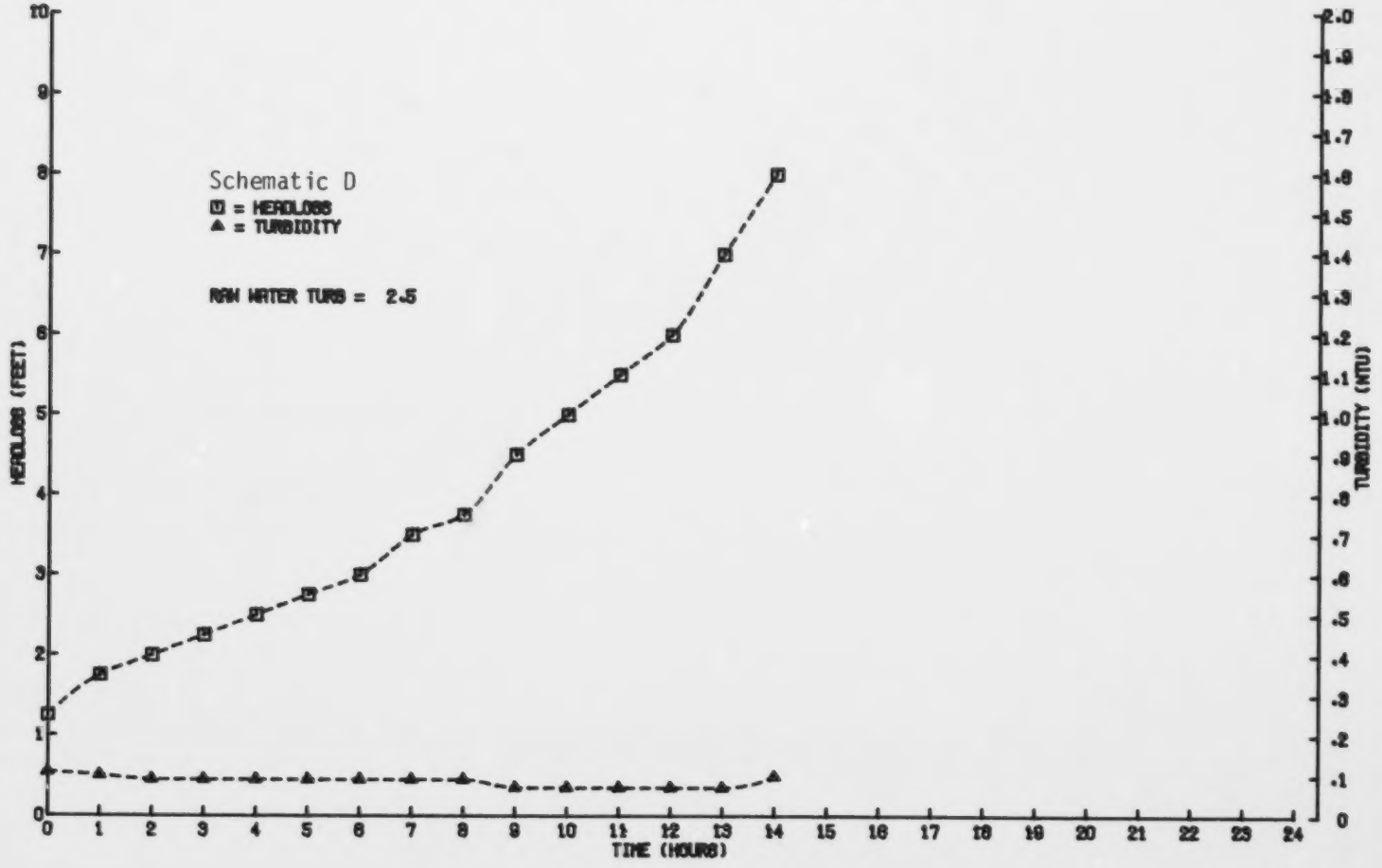
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 122



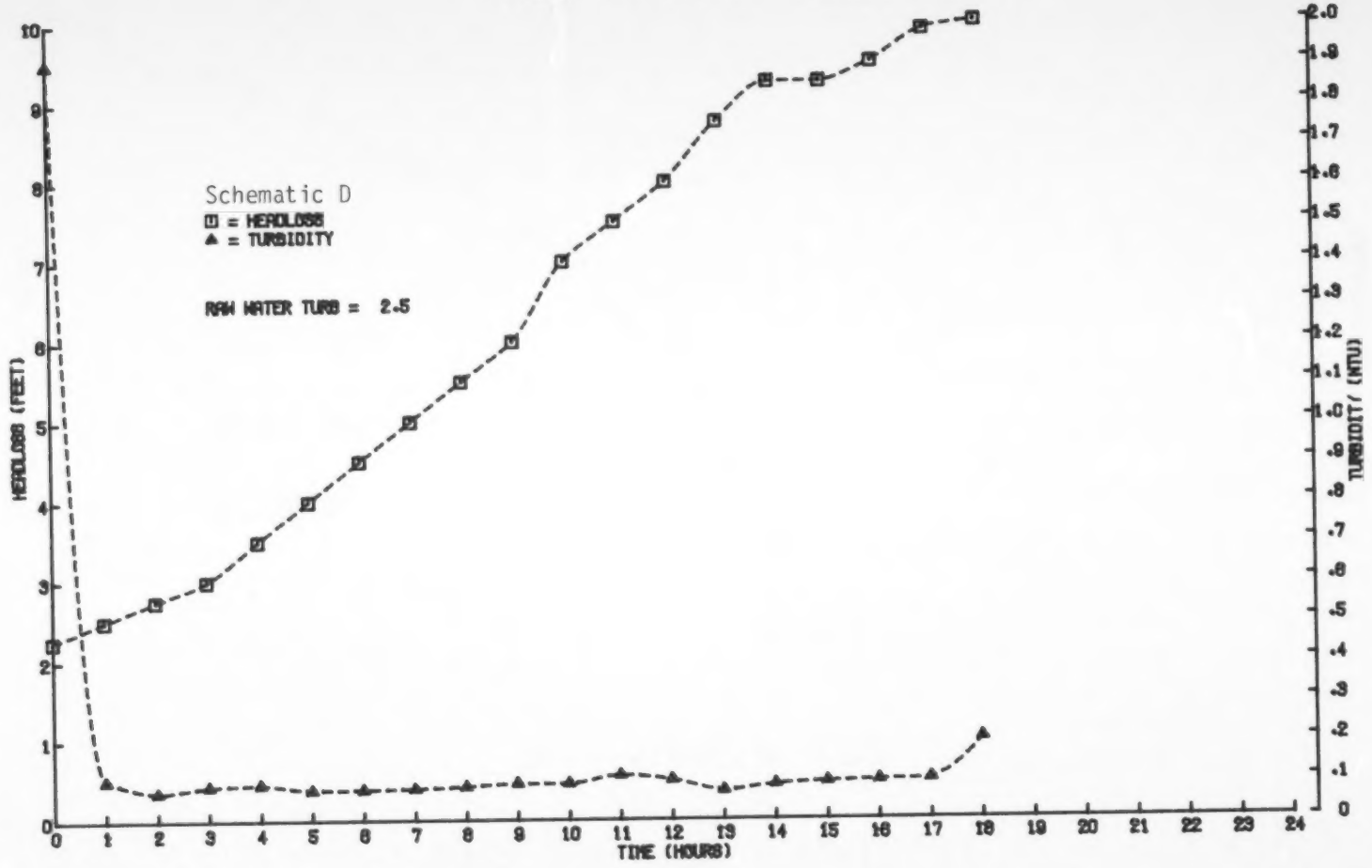
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 122M



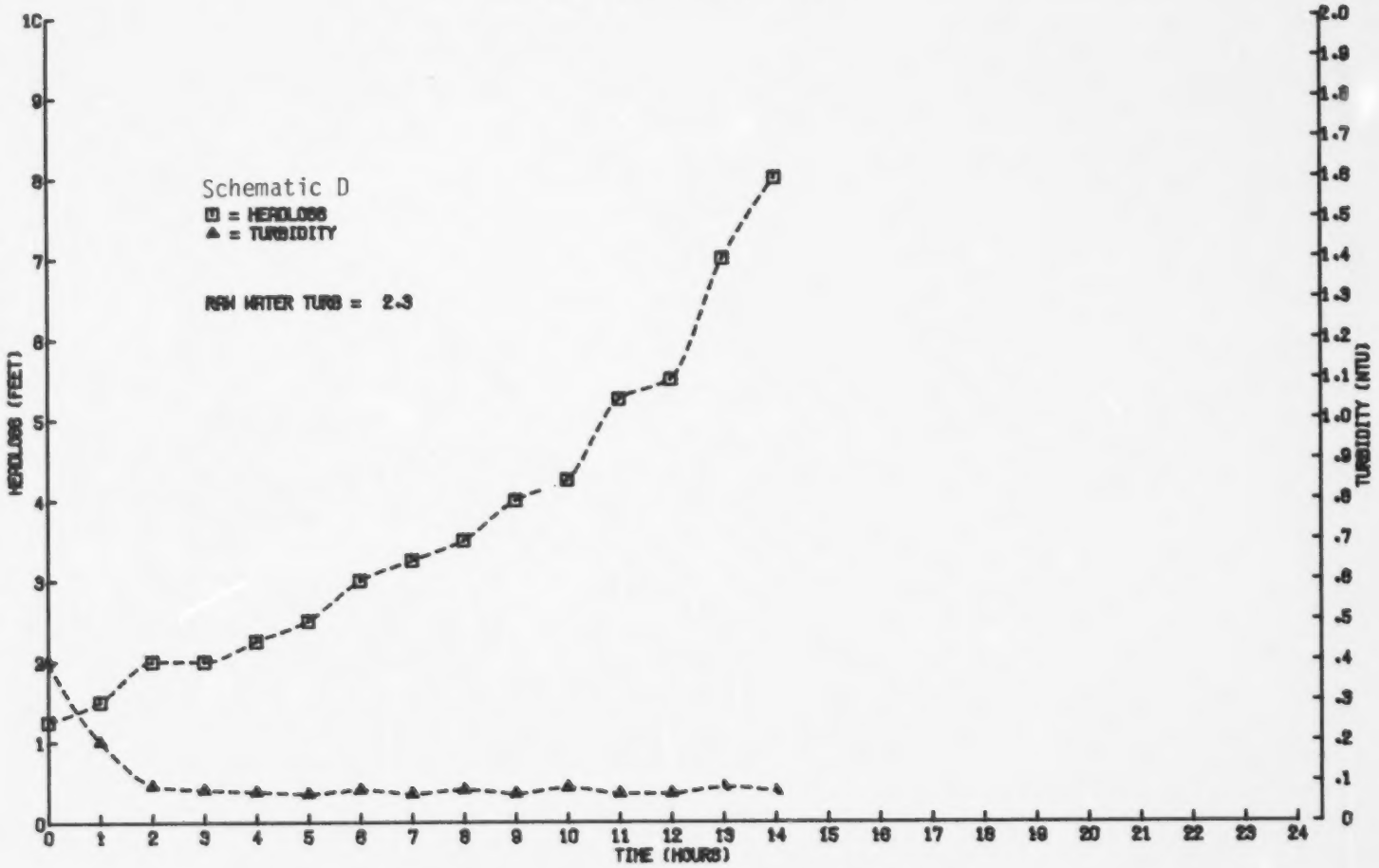
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 123



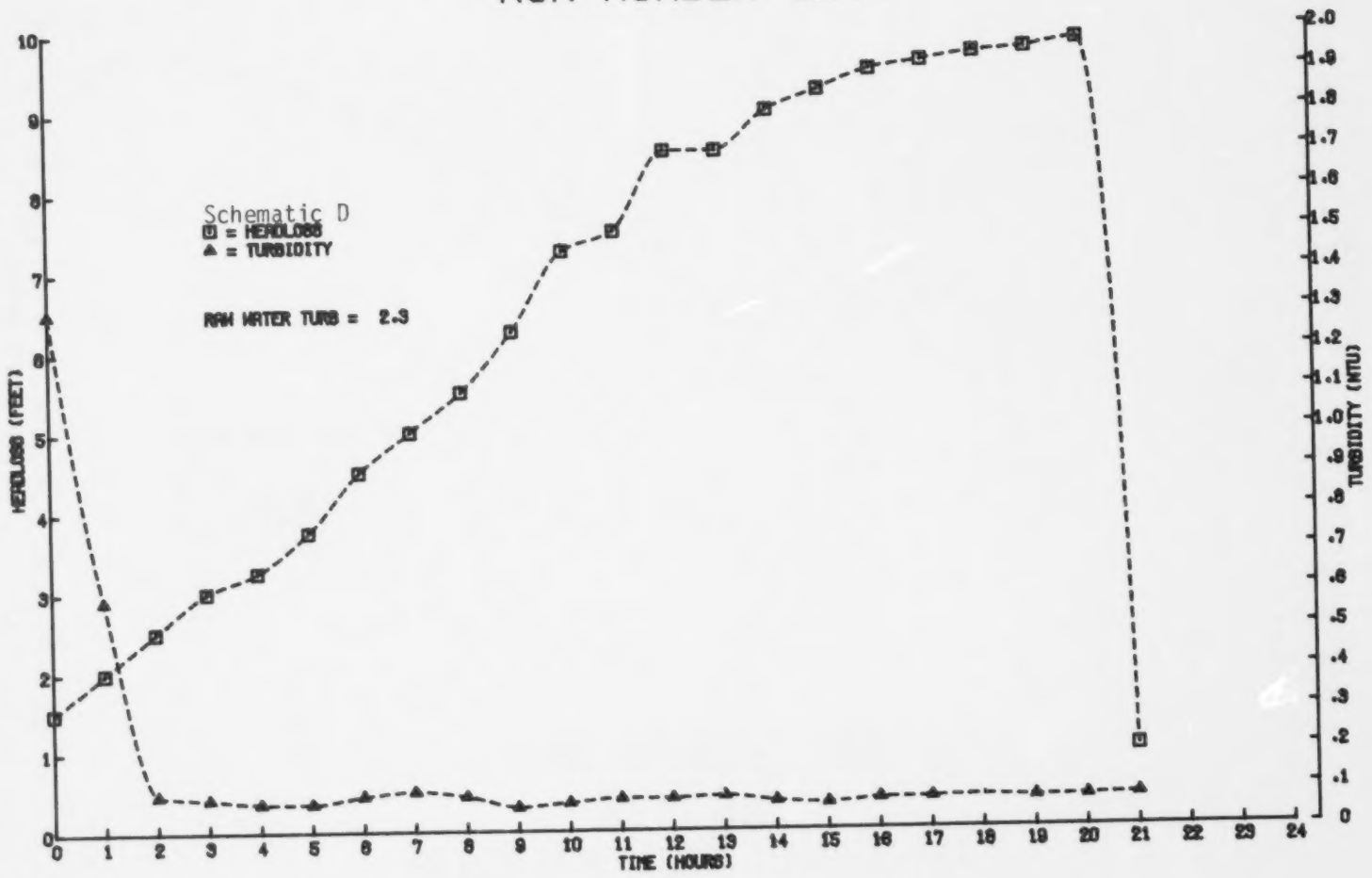
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 123M



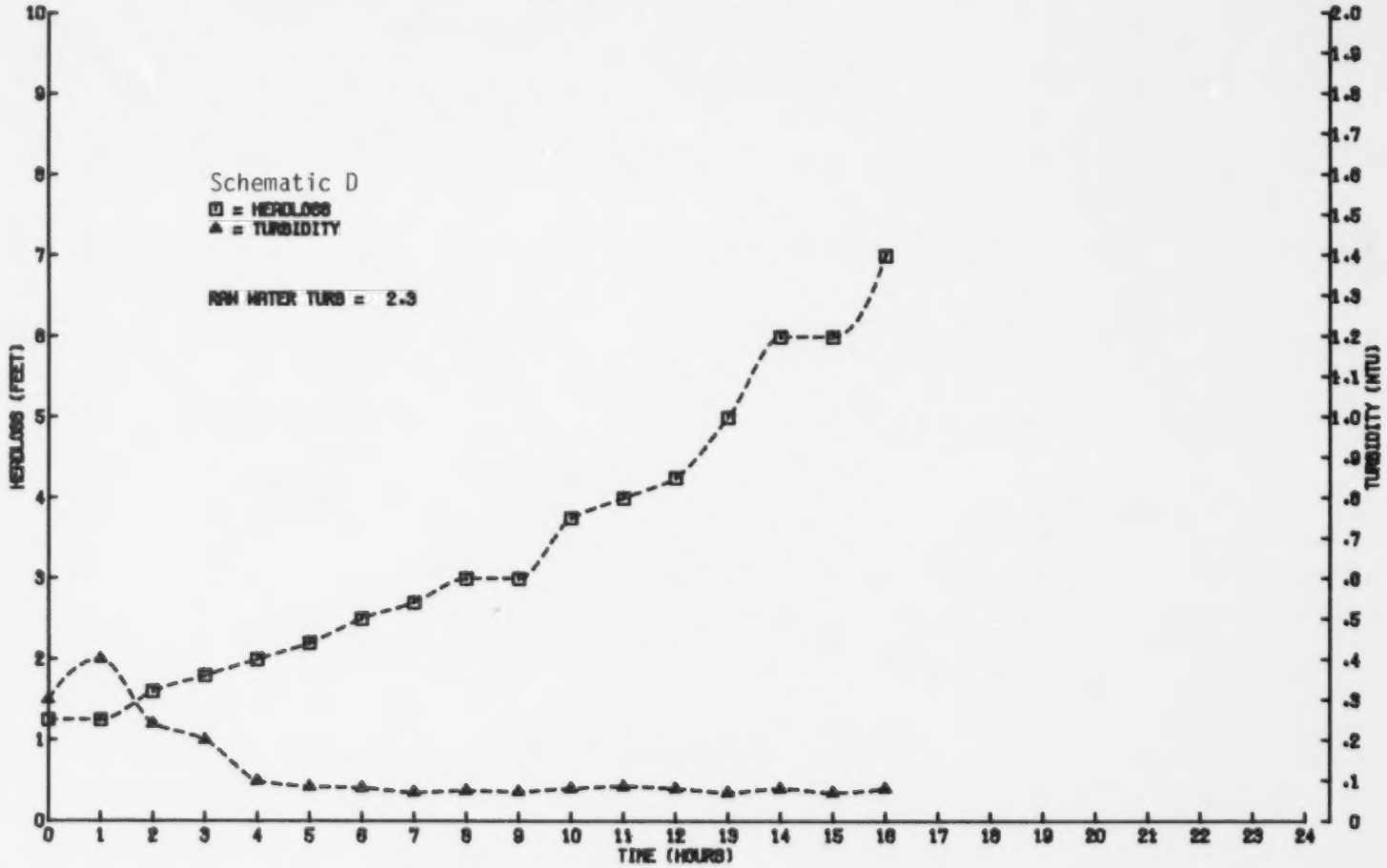
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 124



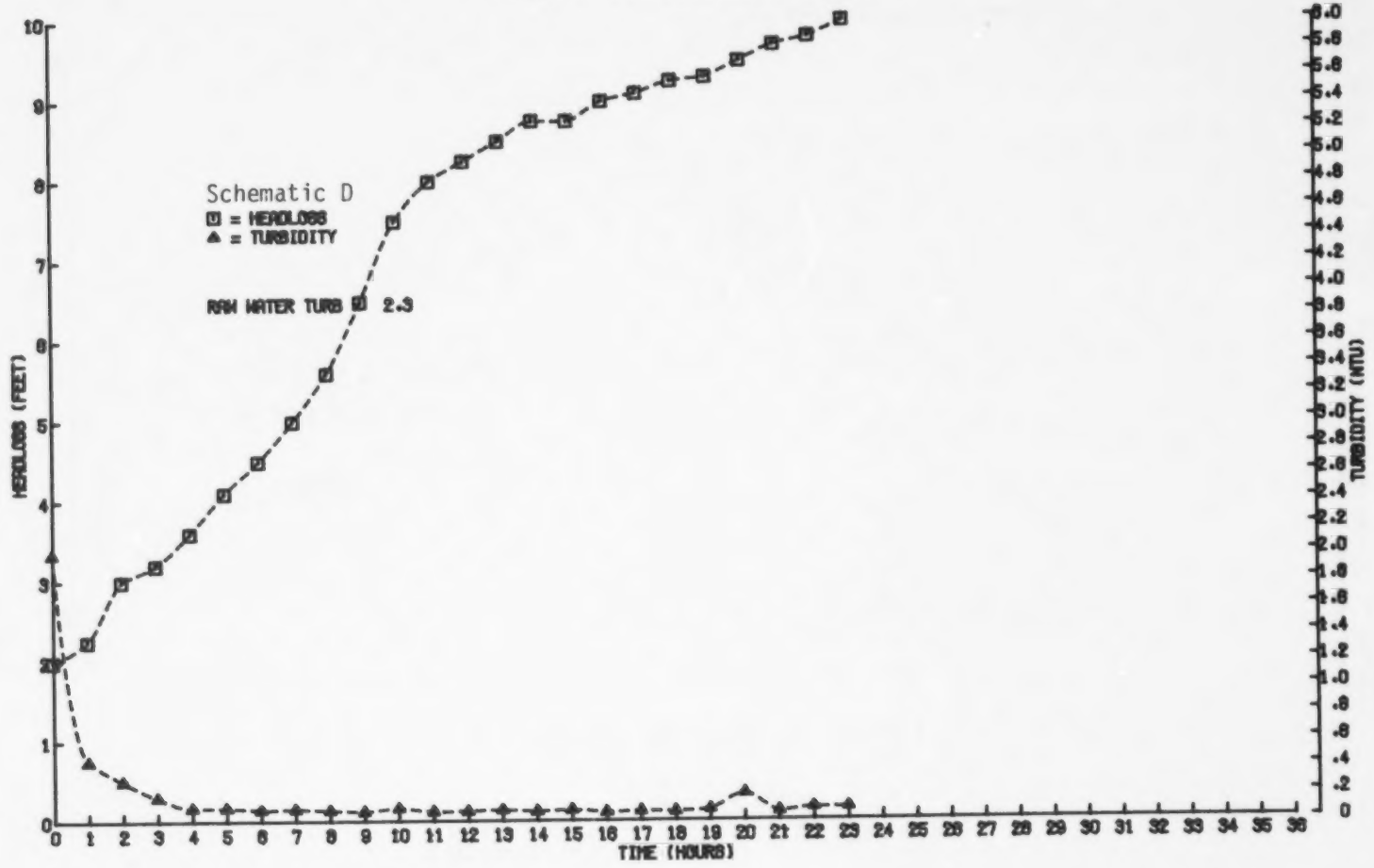
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 124M



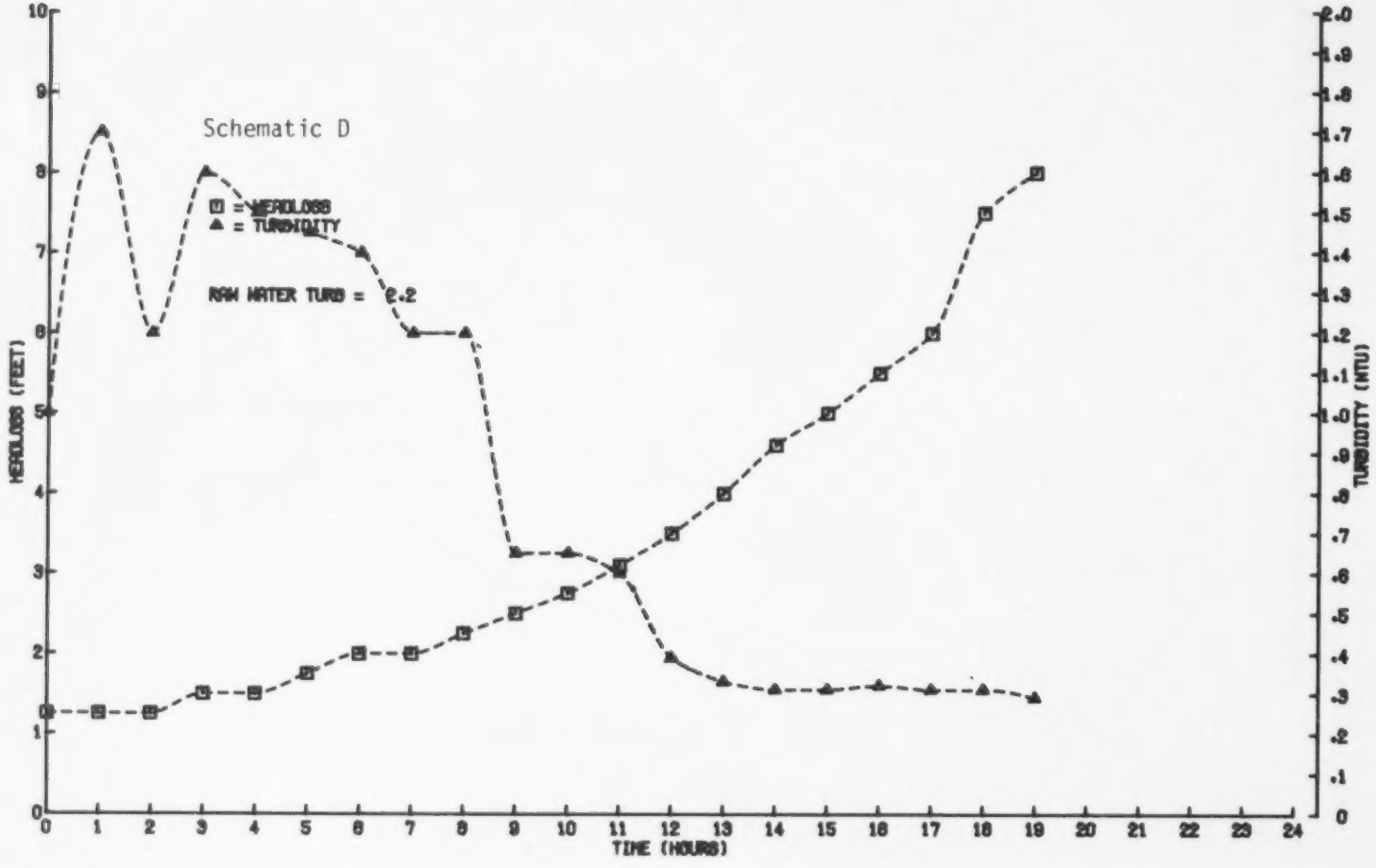
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 125



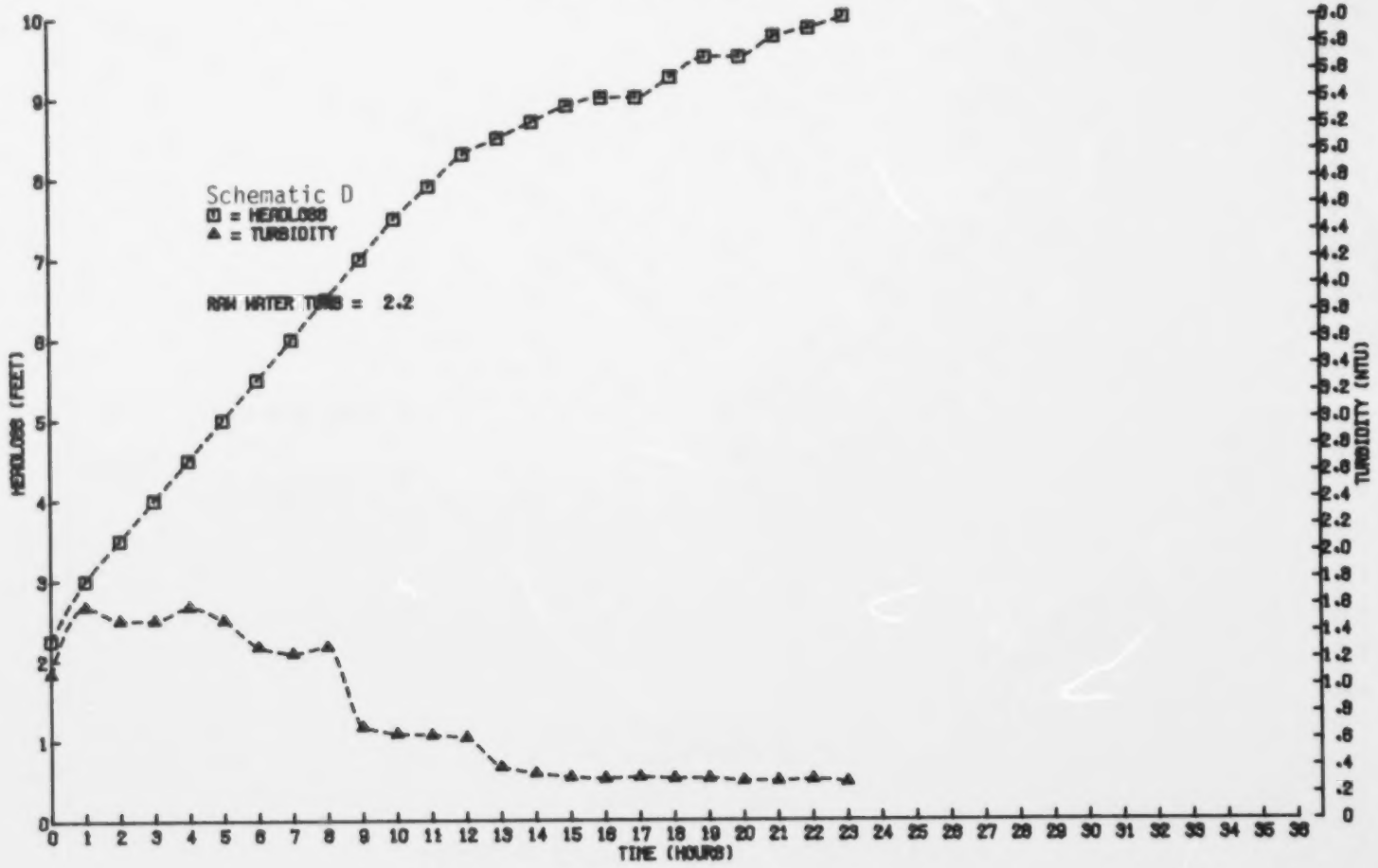
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 125M



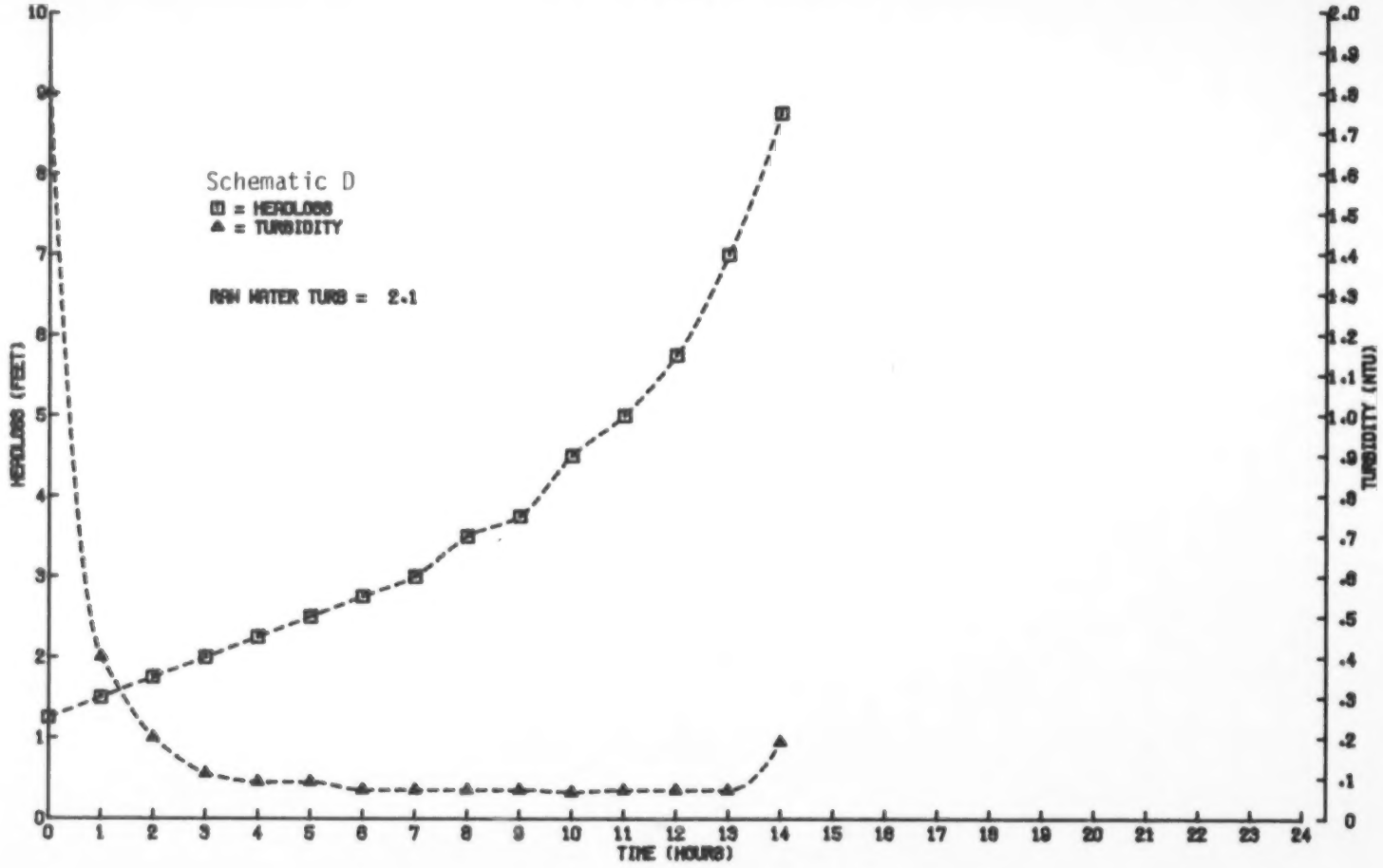
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 126



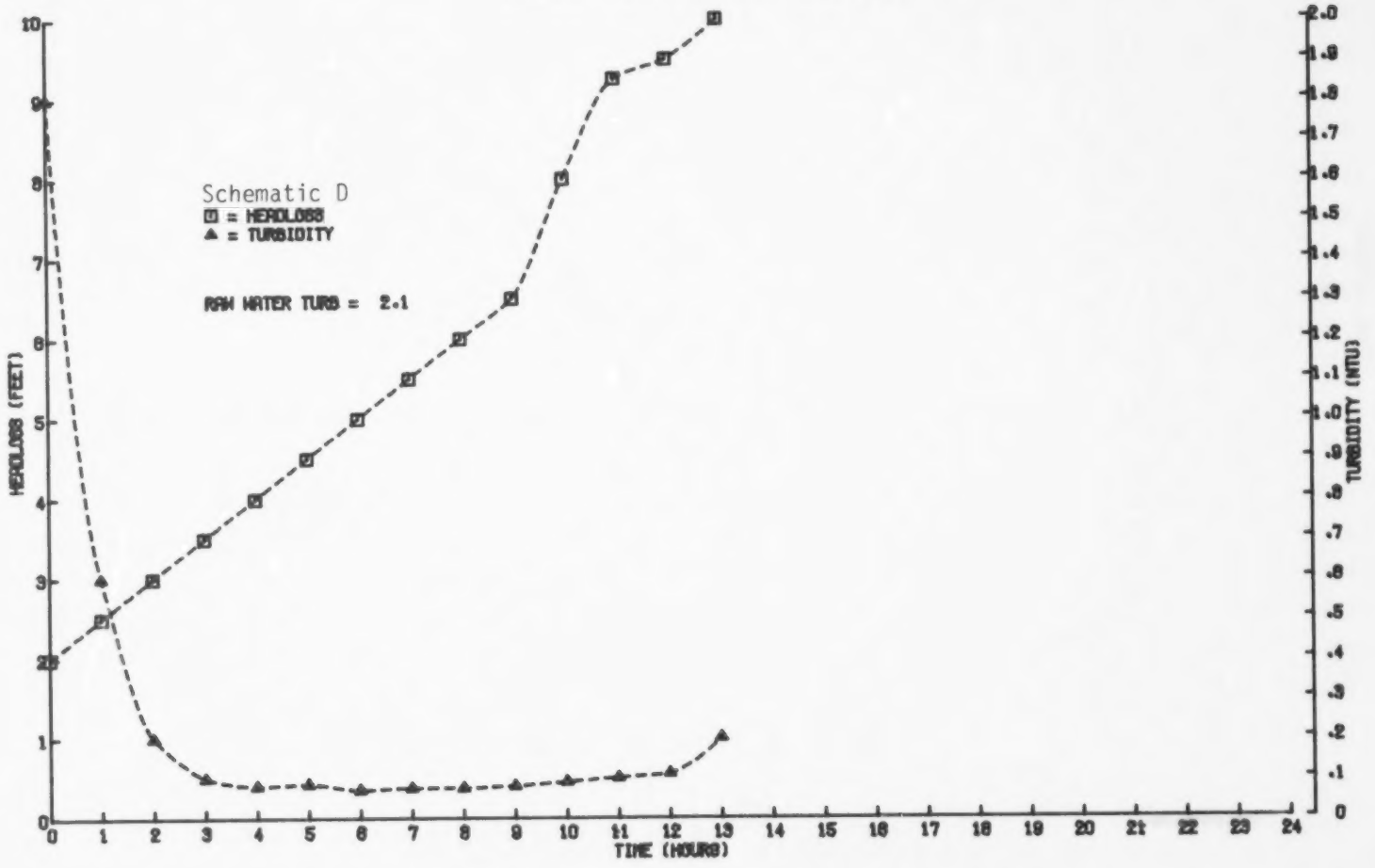
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 126M



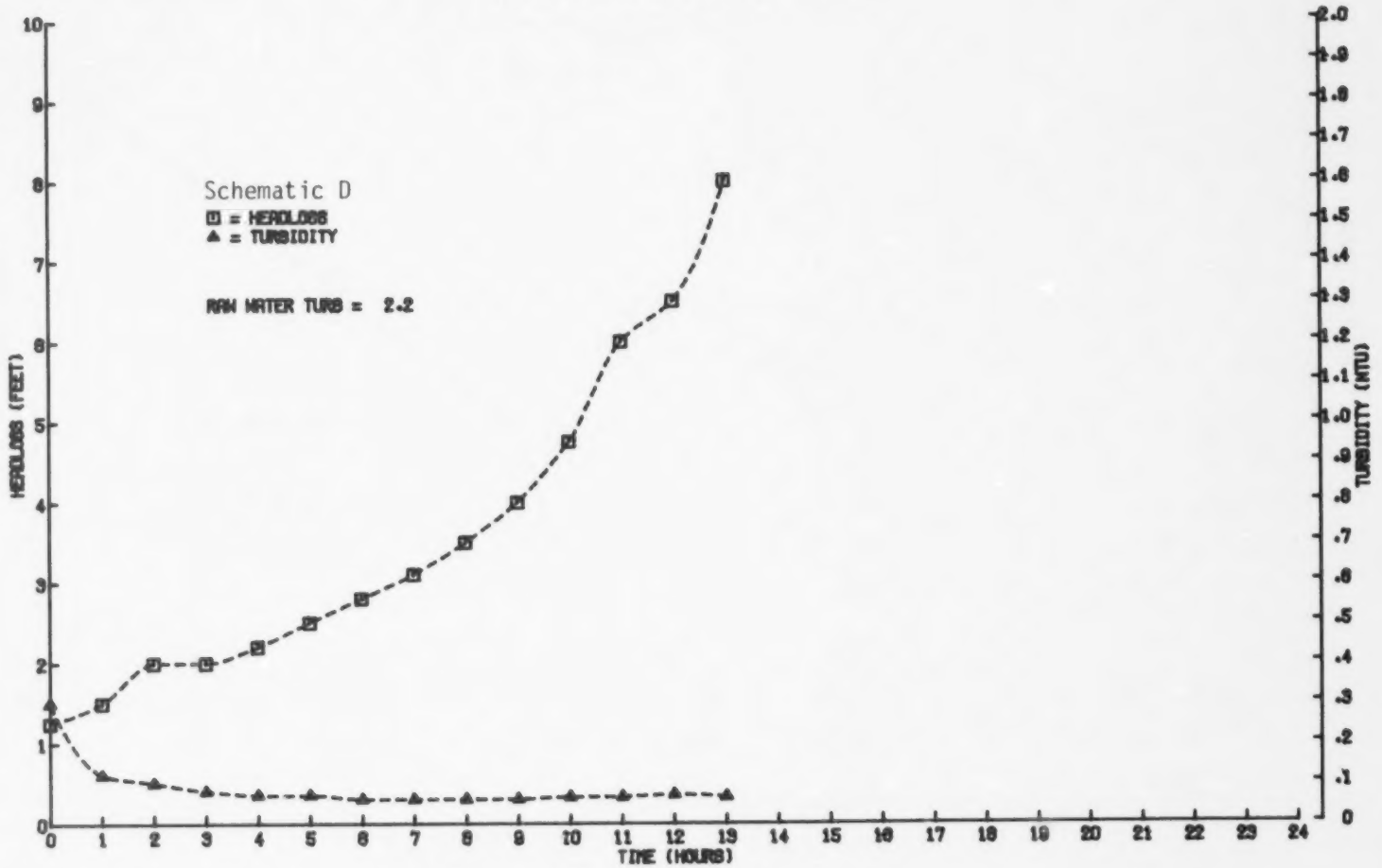
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 127



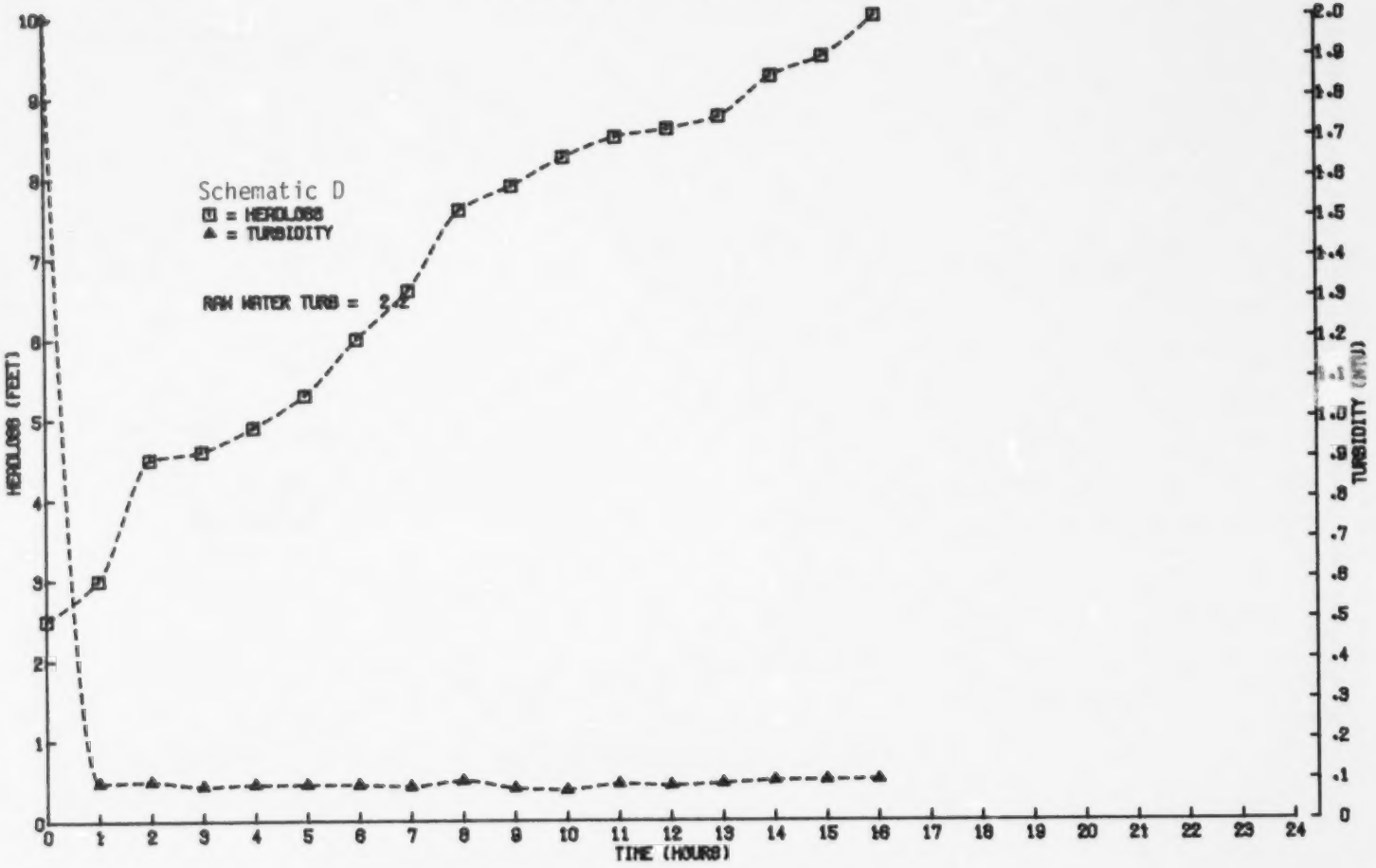
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 127M



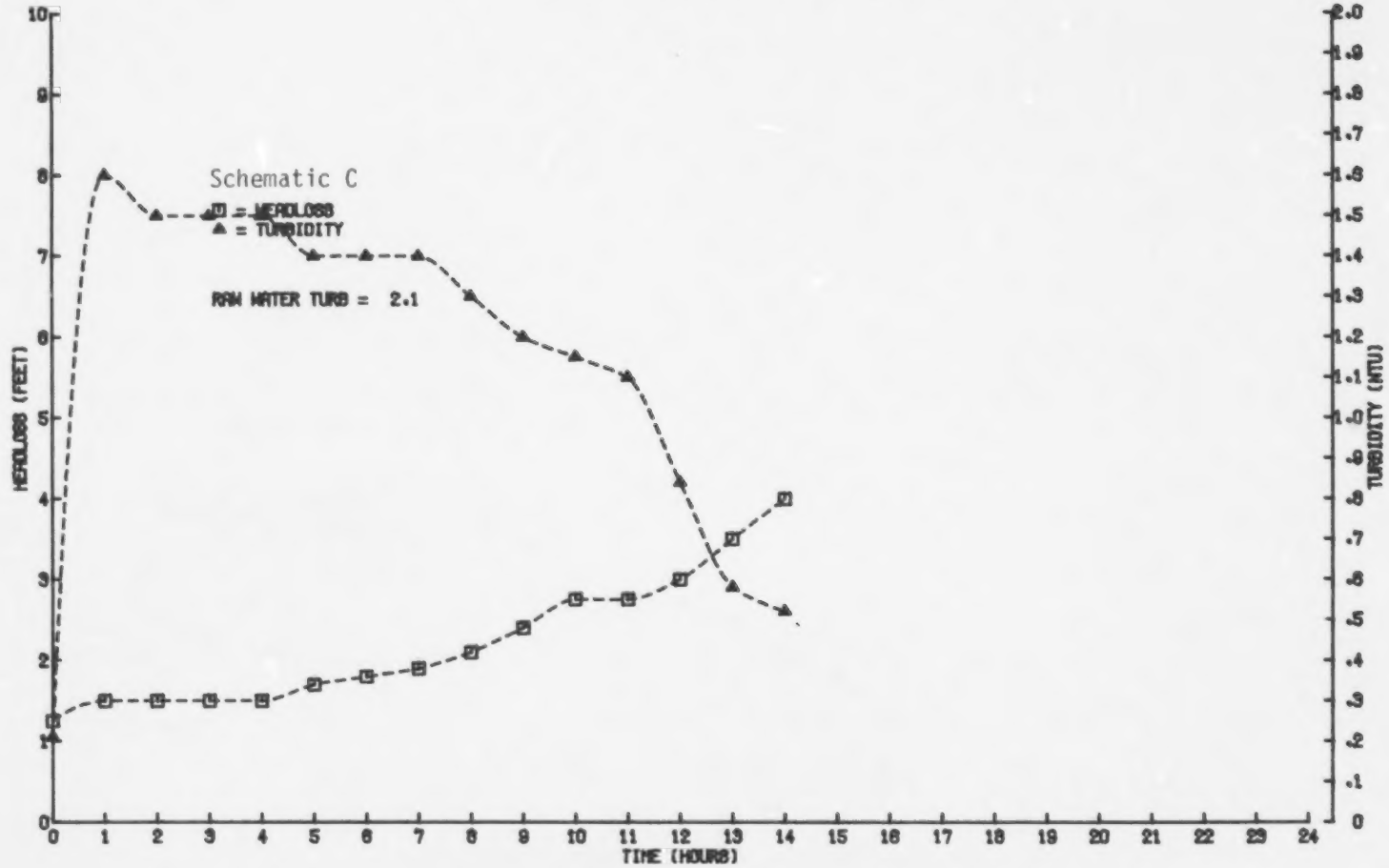
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 128



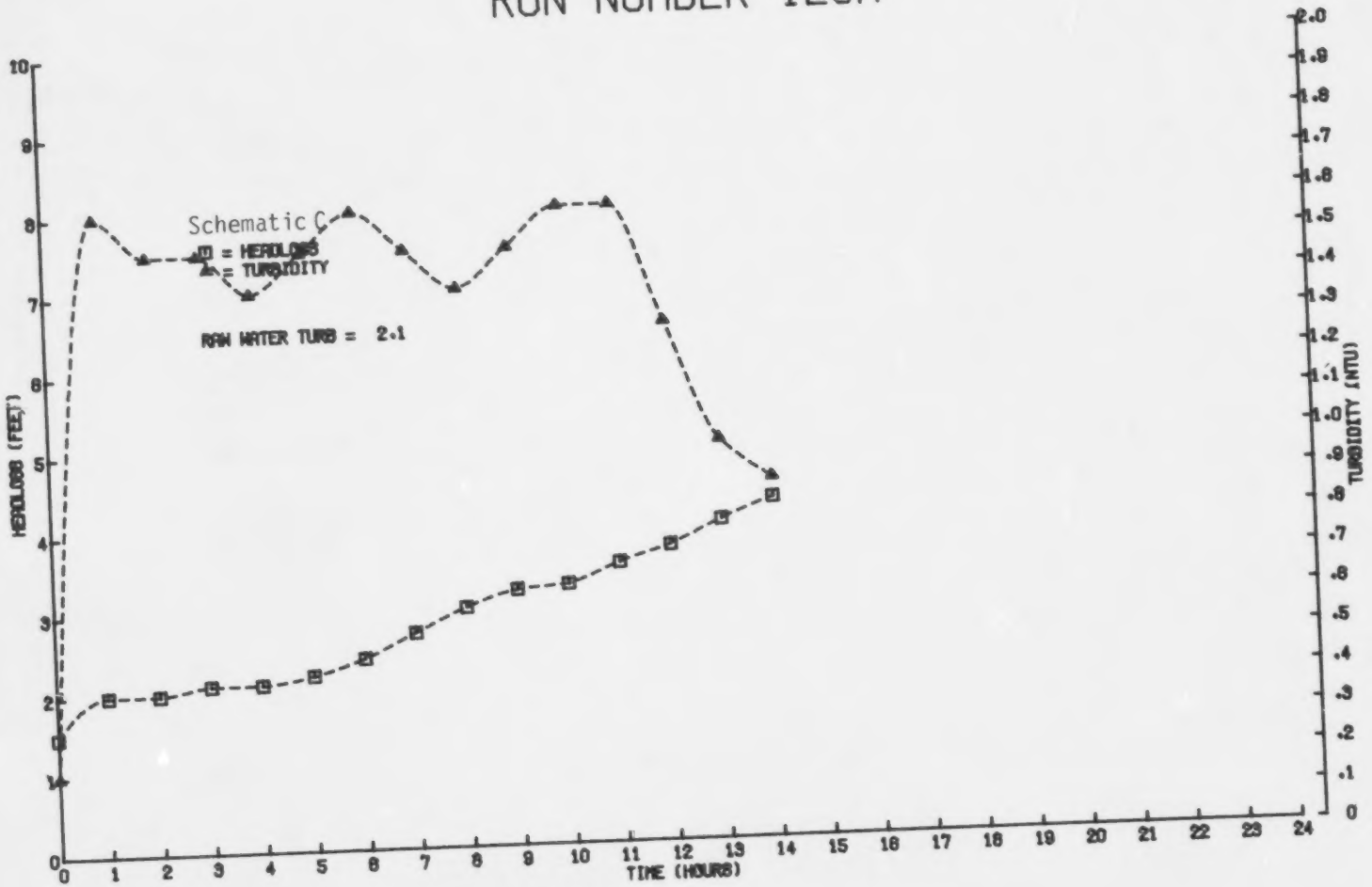
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 128M



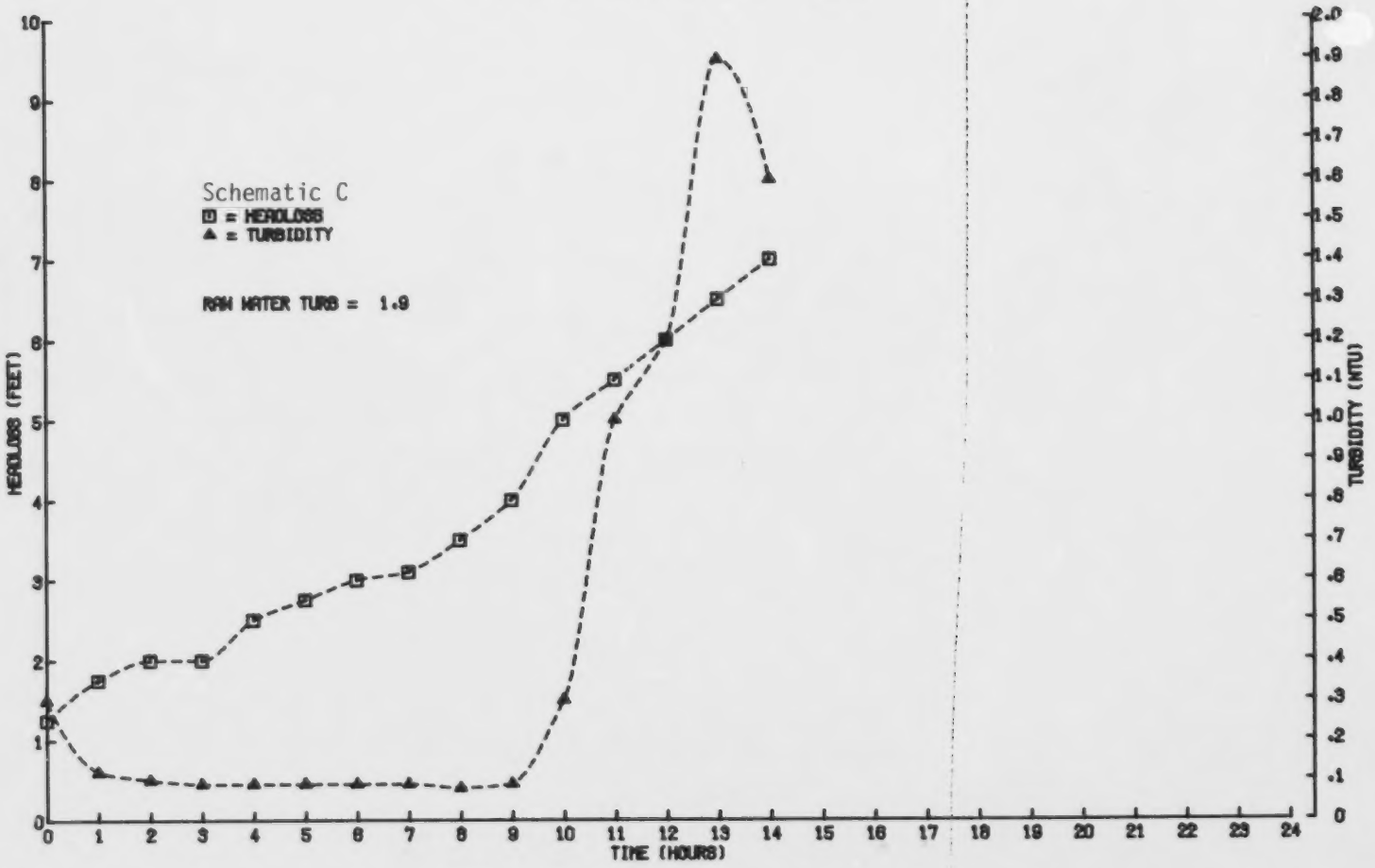
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 129



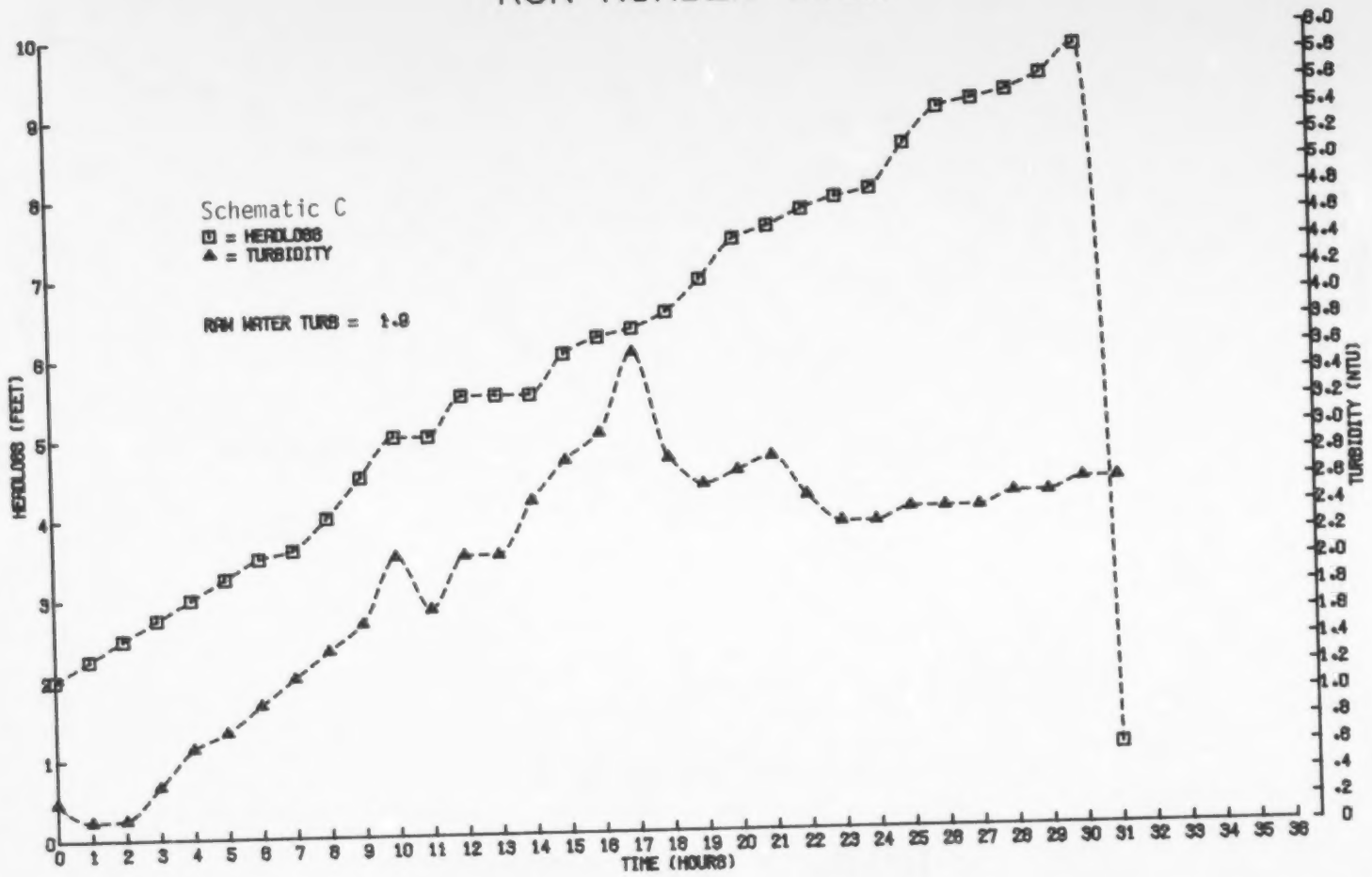
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 129M



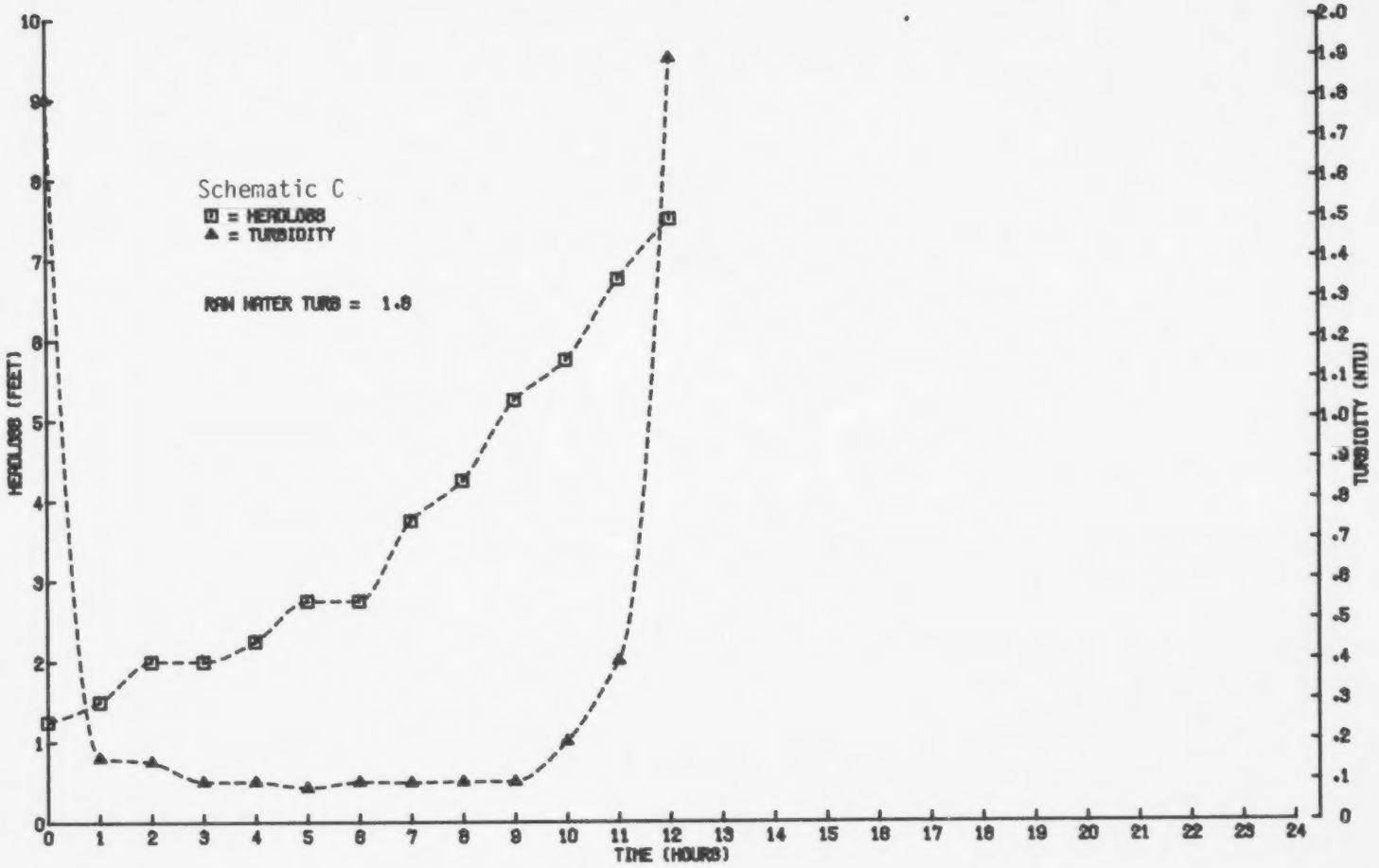
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 130



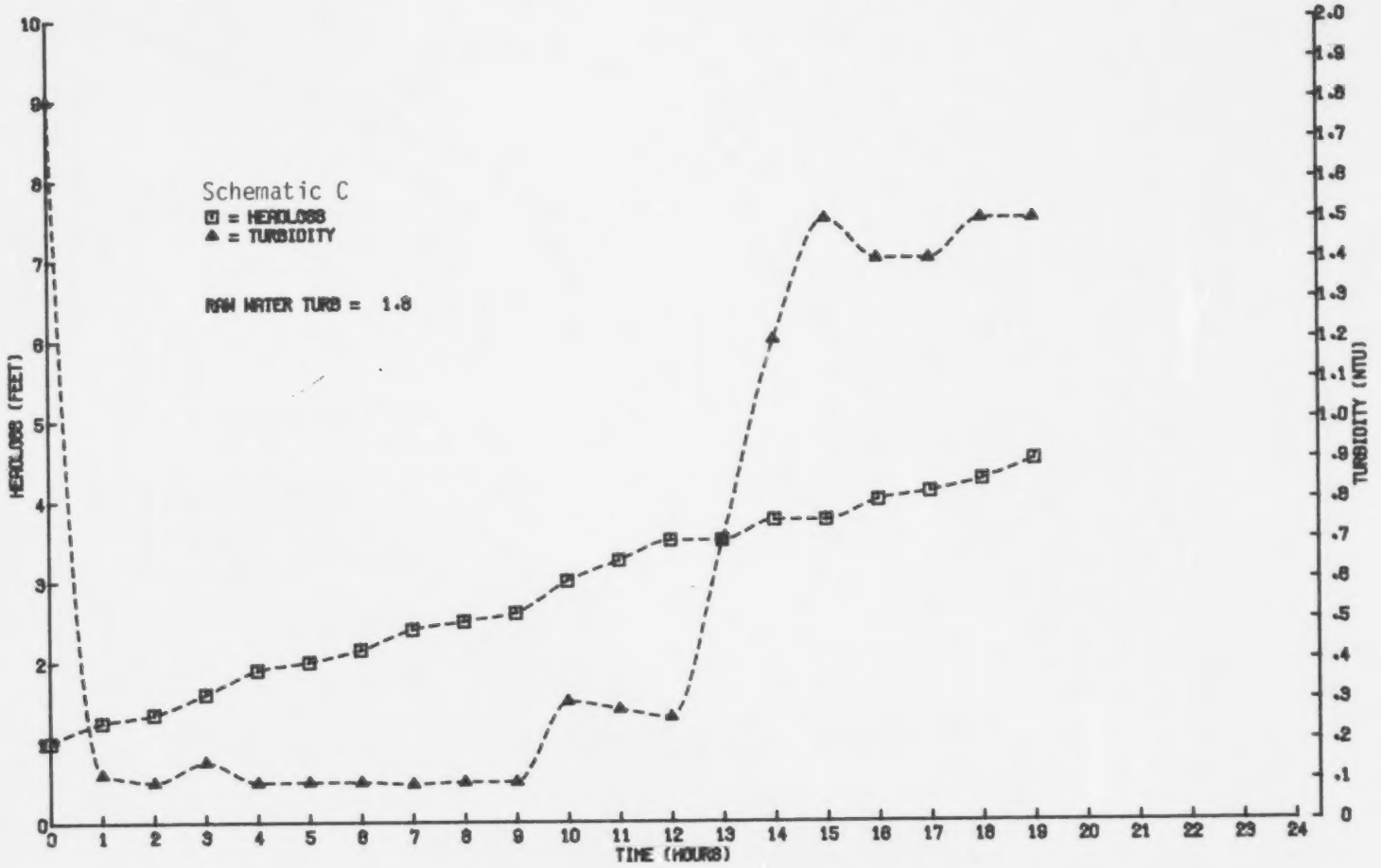
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 130M



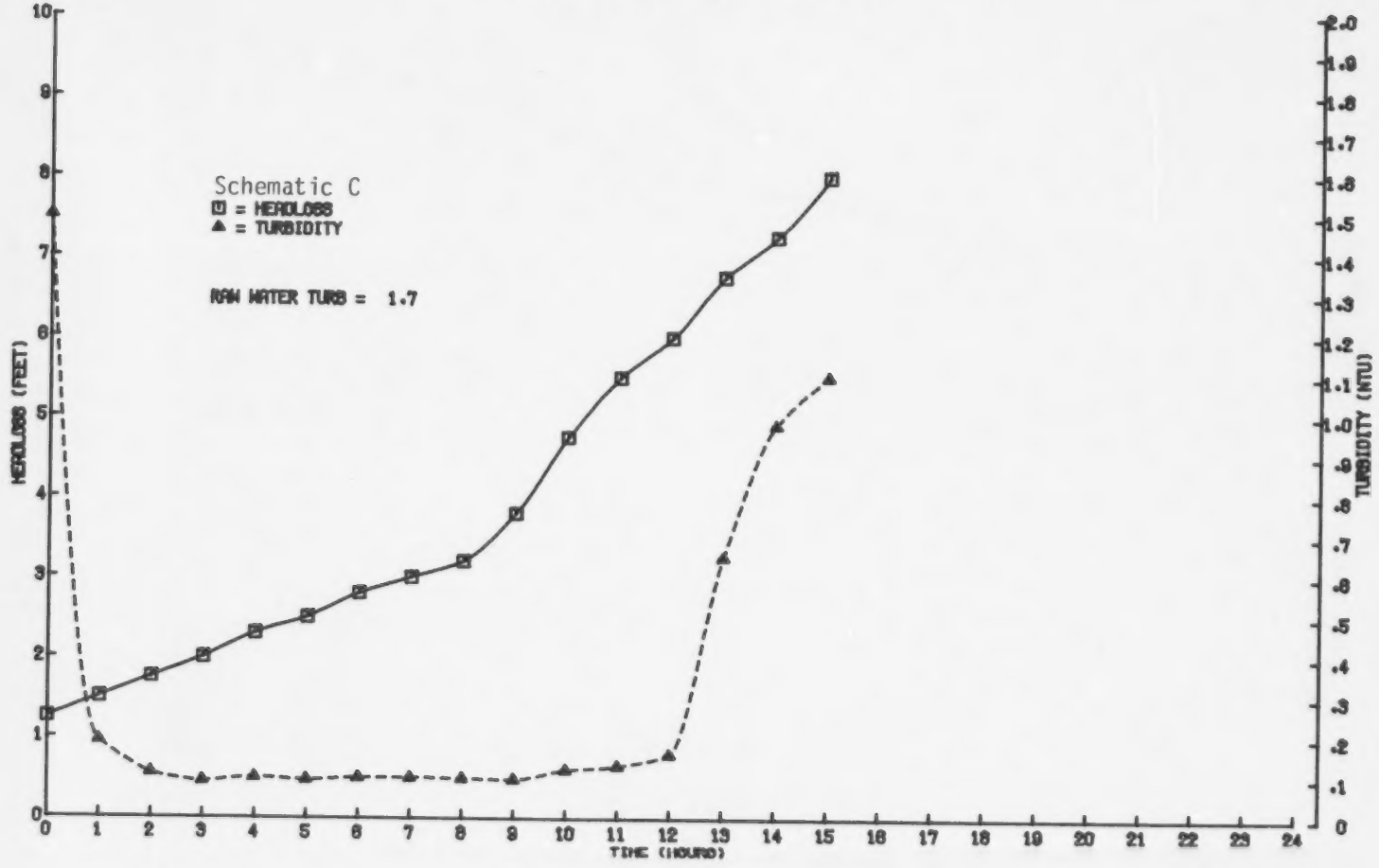
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 131



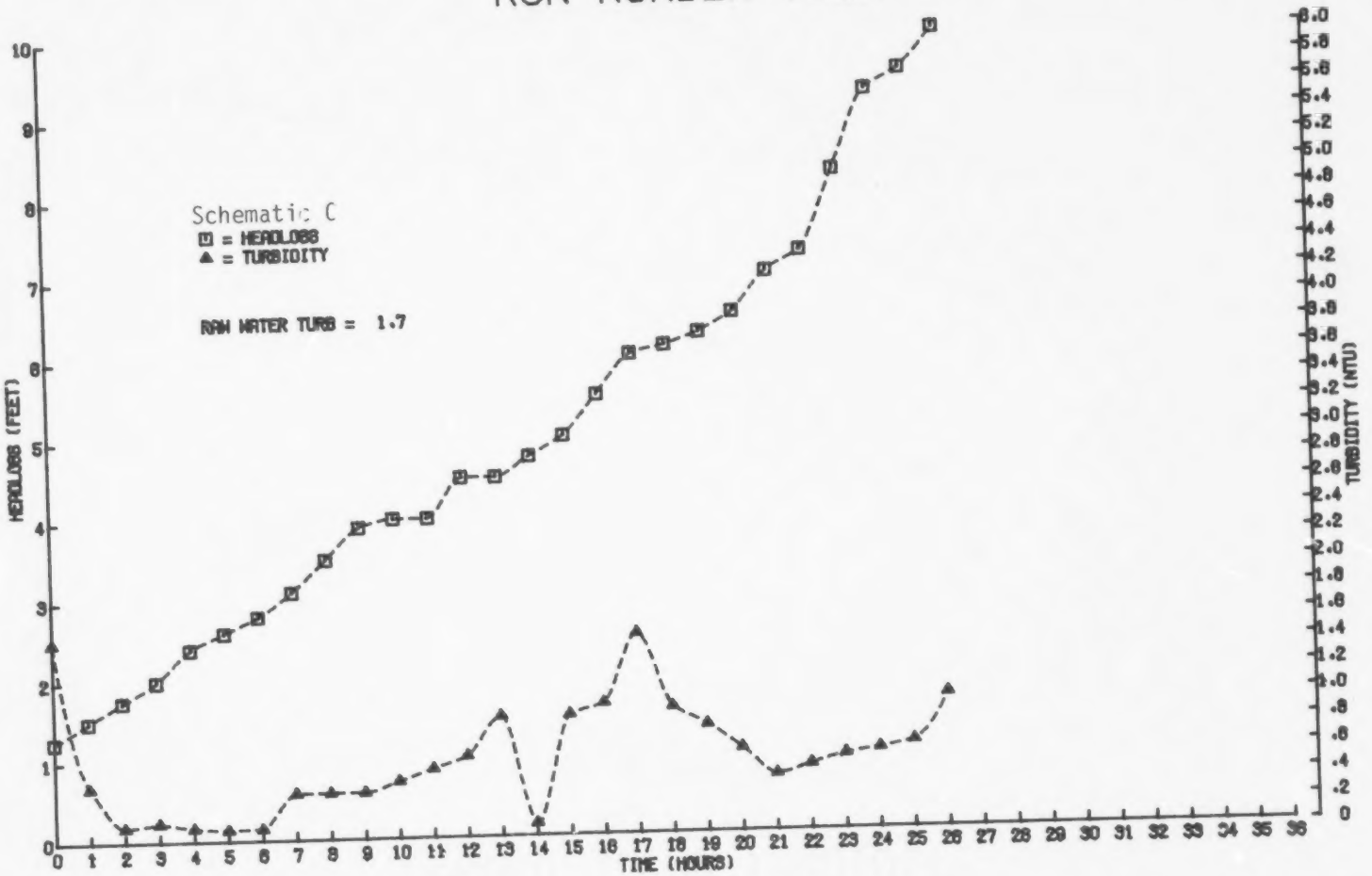
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 131M



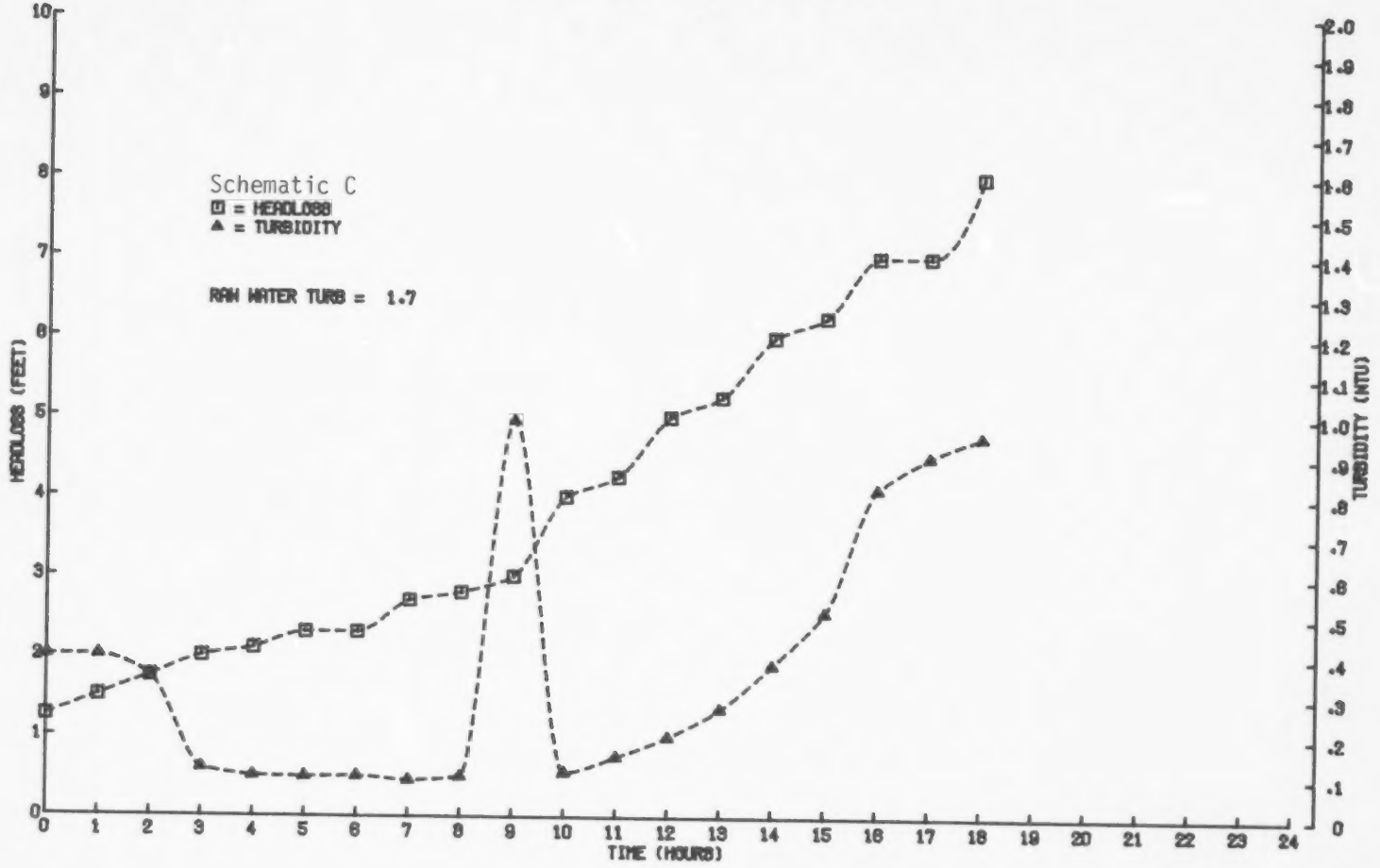
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 132



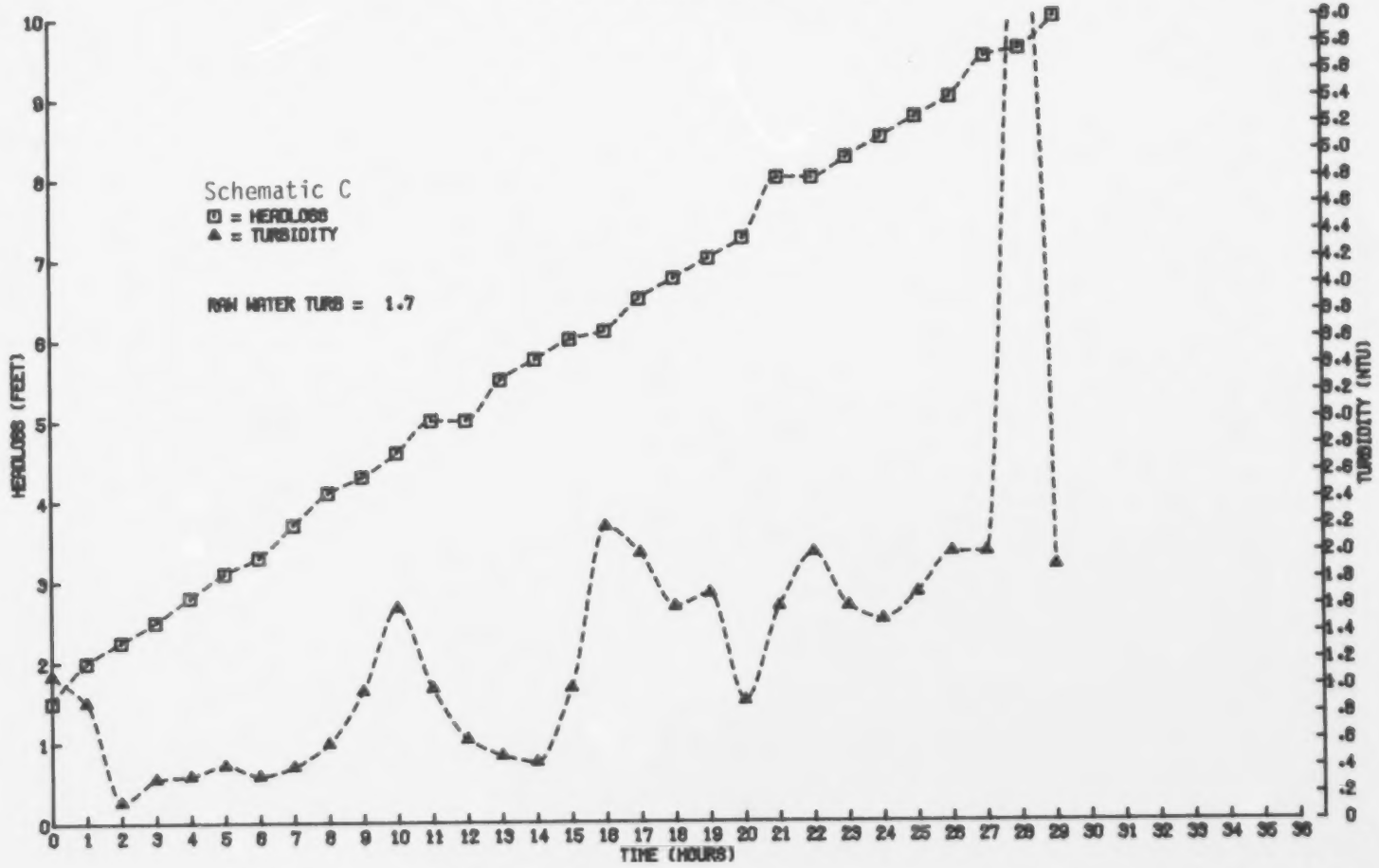
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 132M



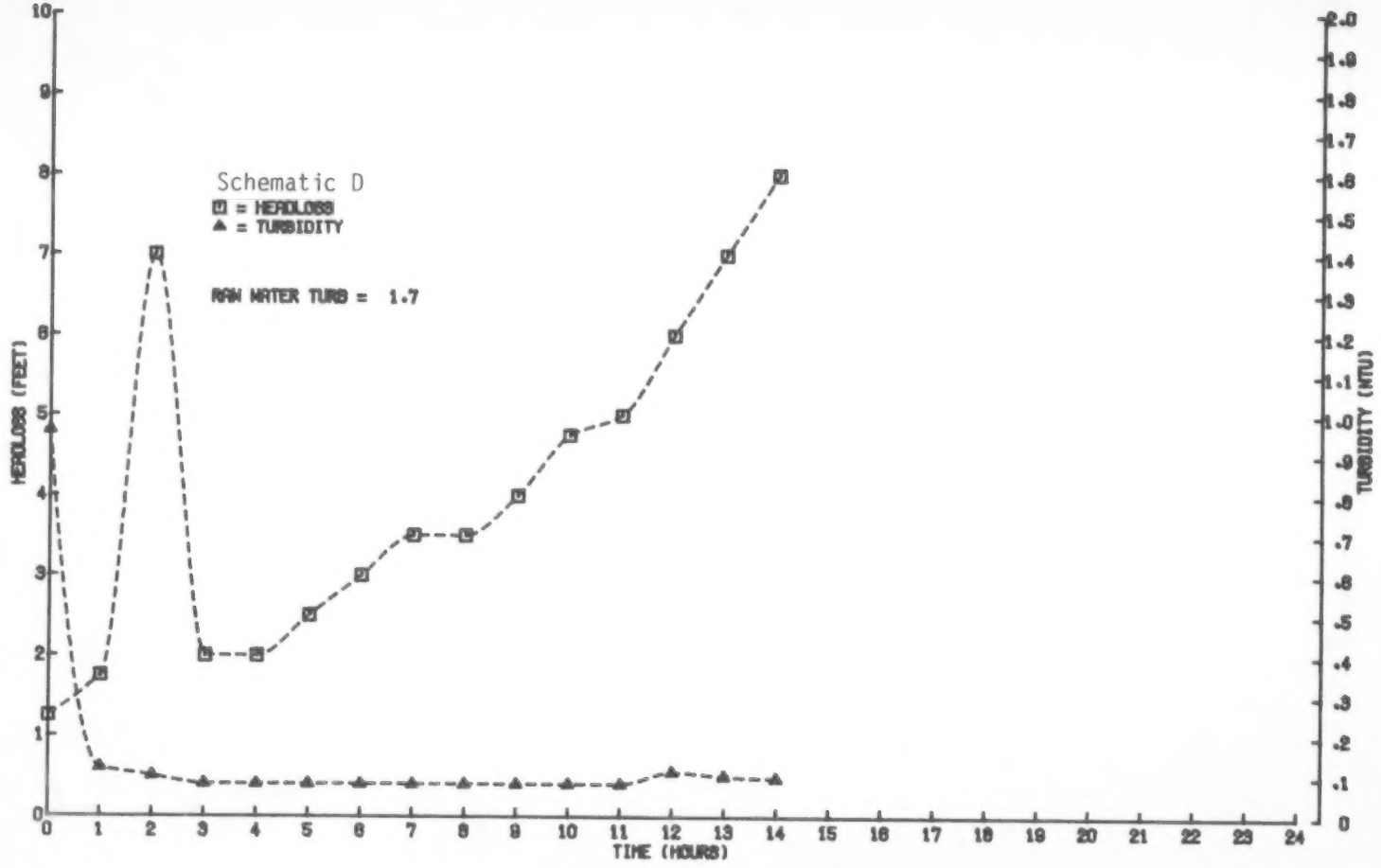
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 133



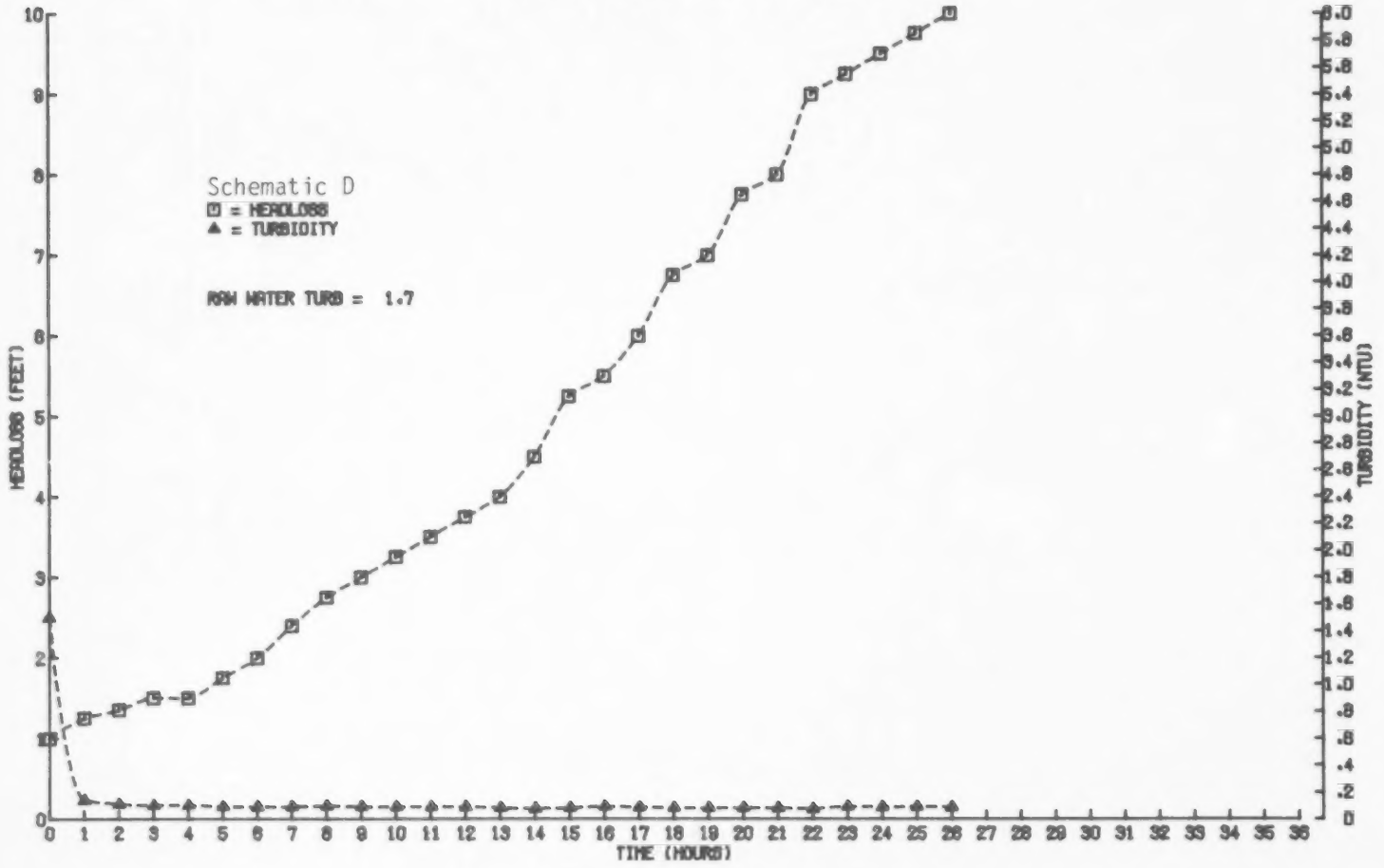
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 133M



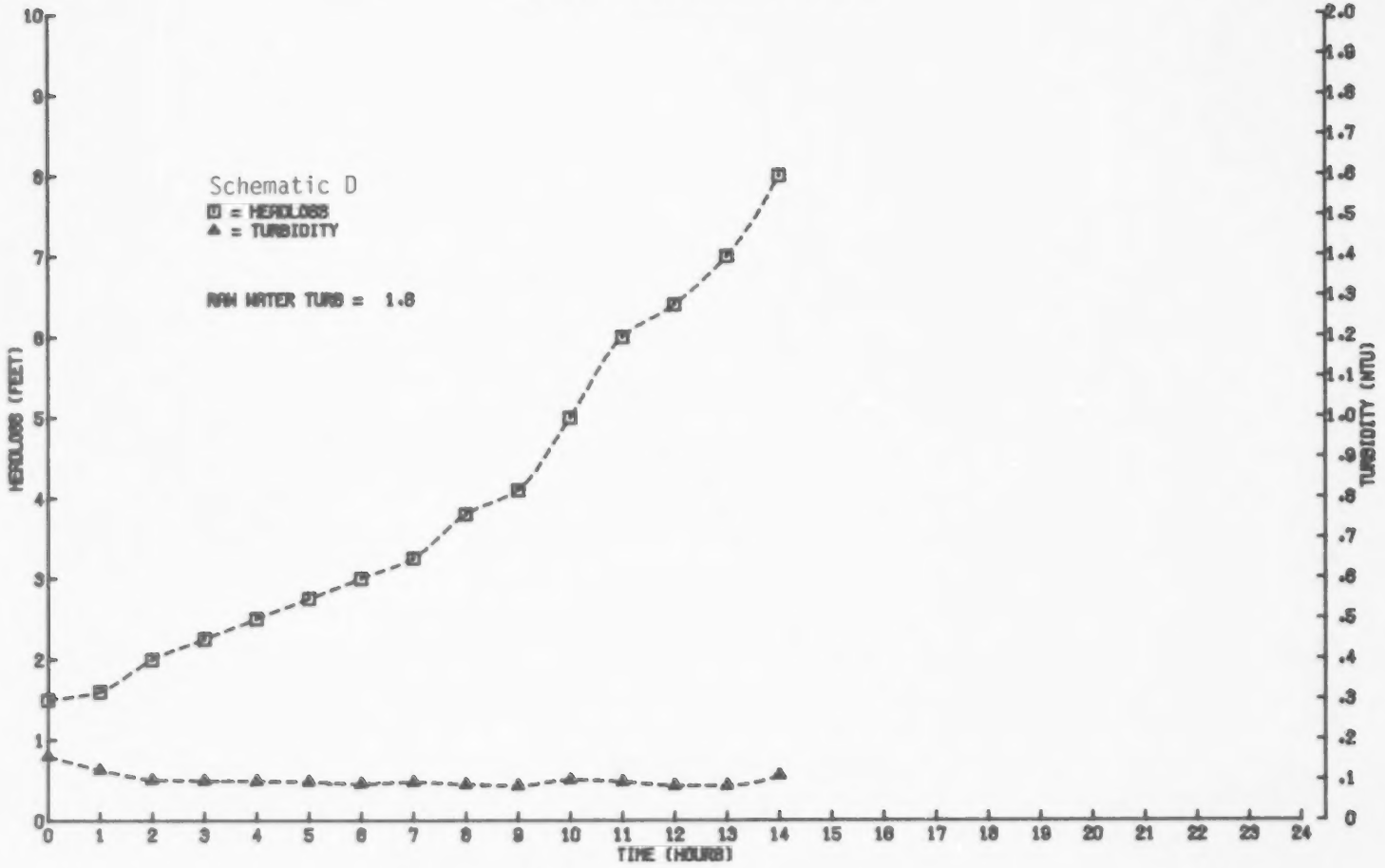
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 134



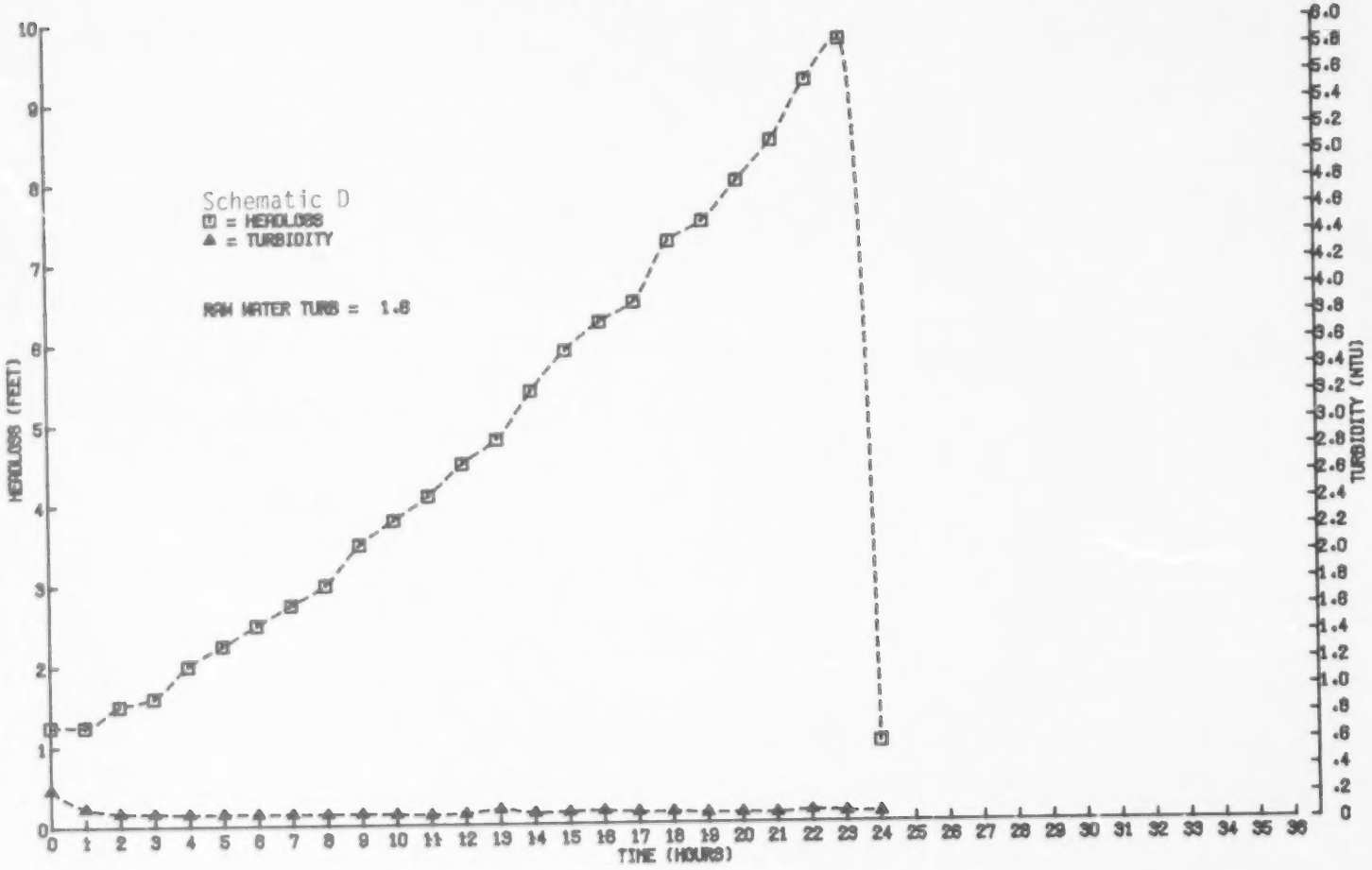
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 134M



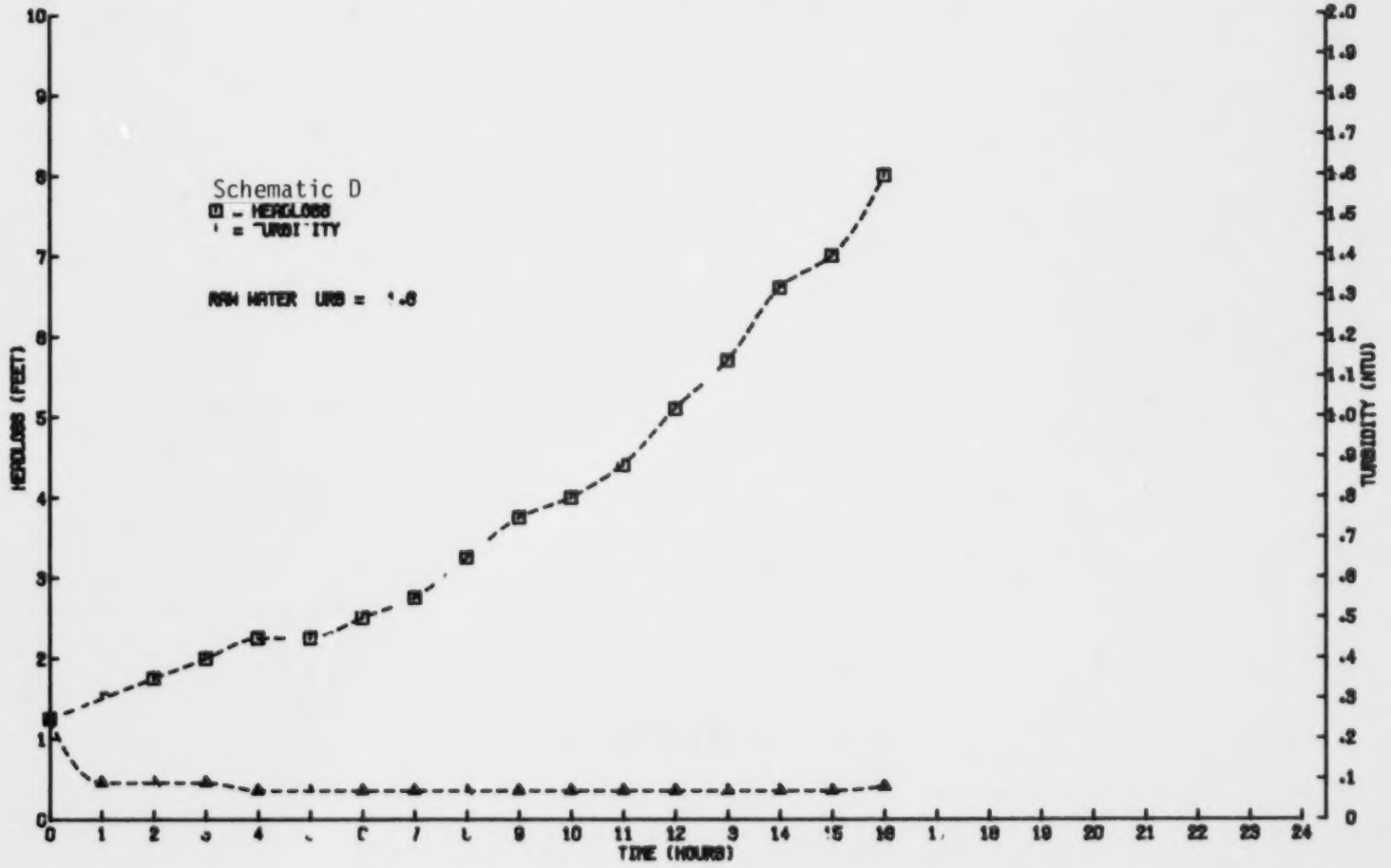
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 135



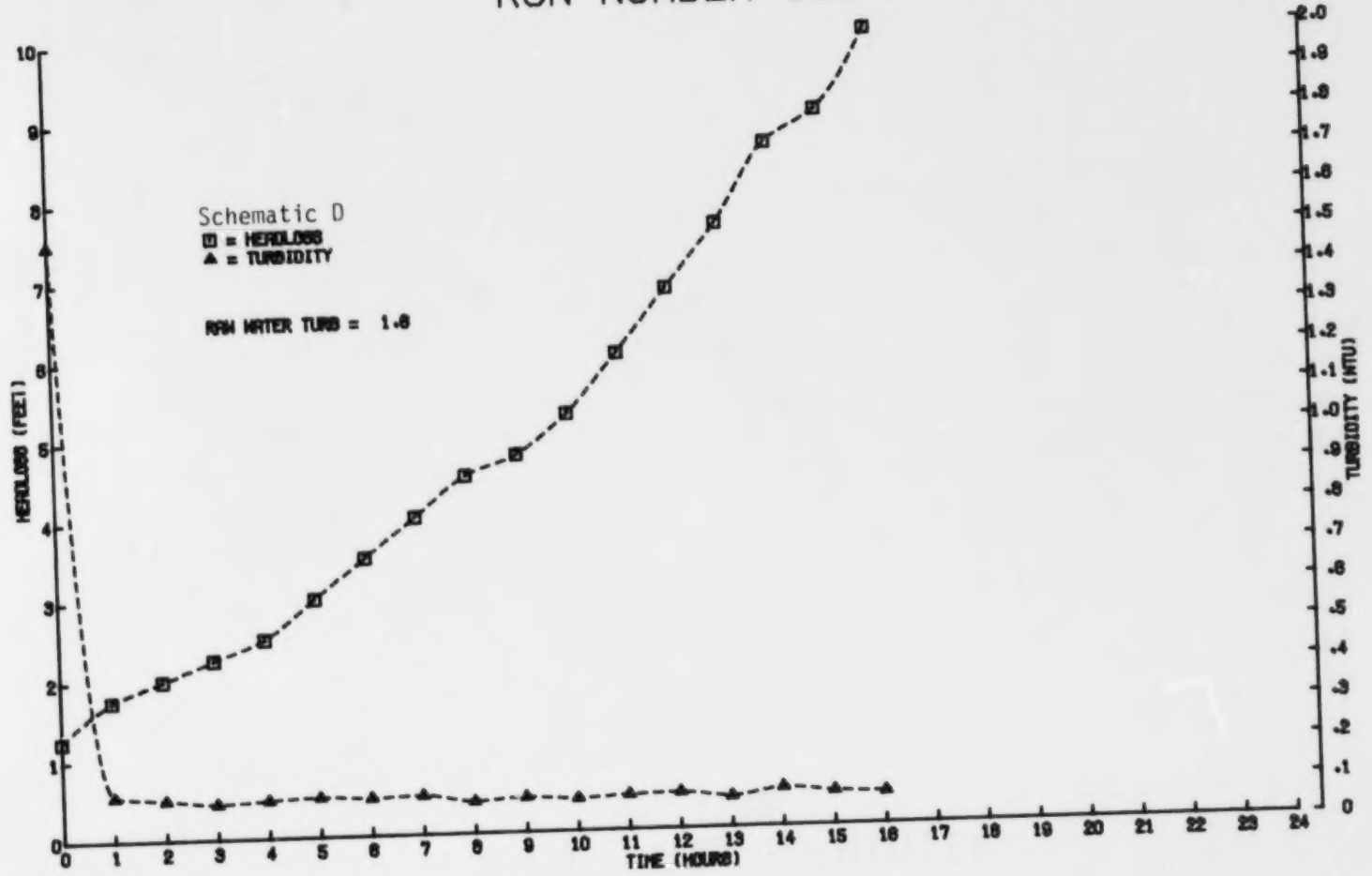
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 135M



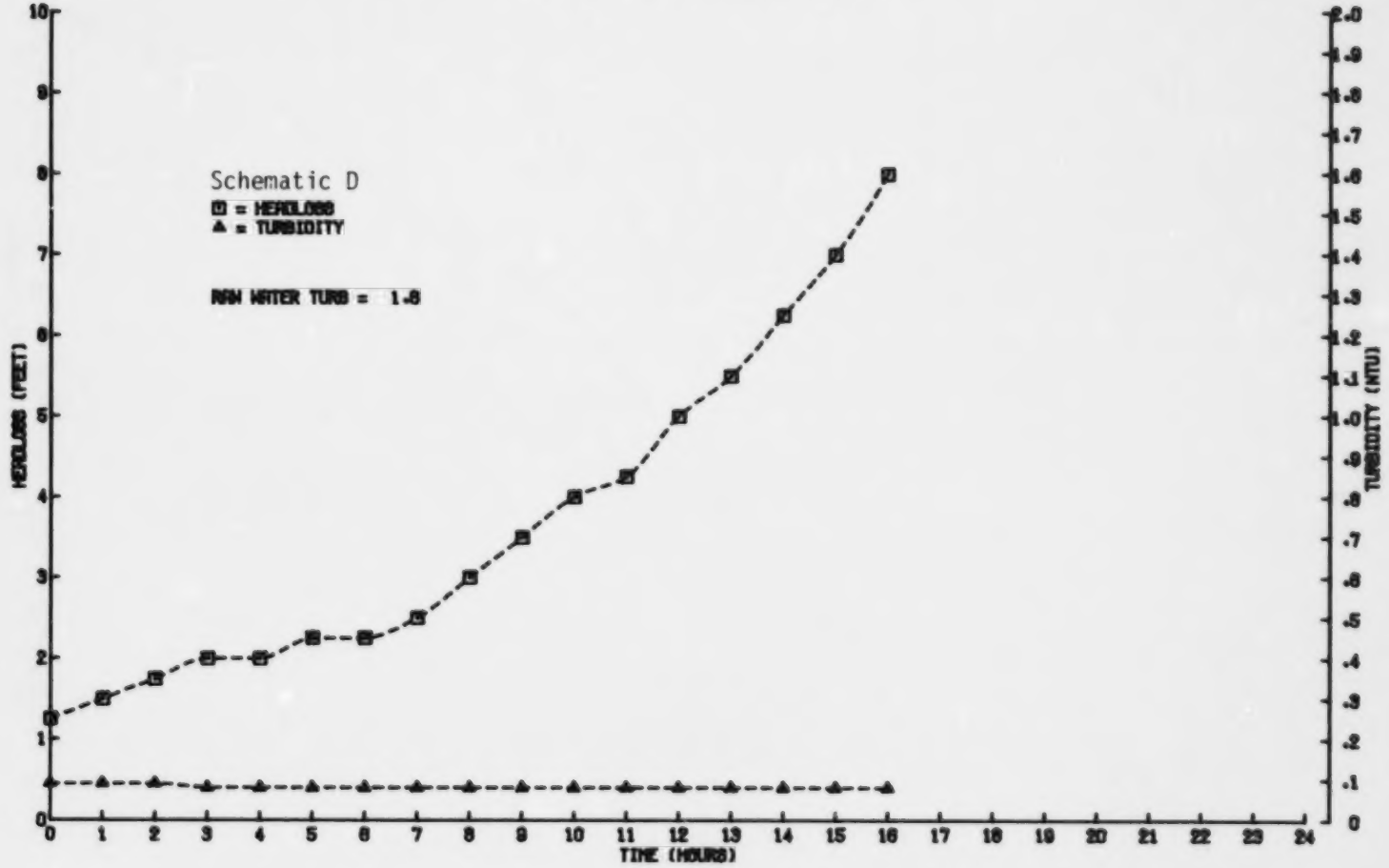
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 136



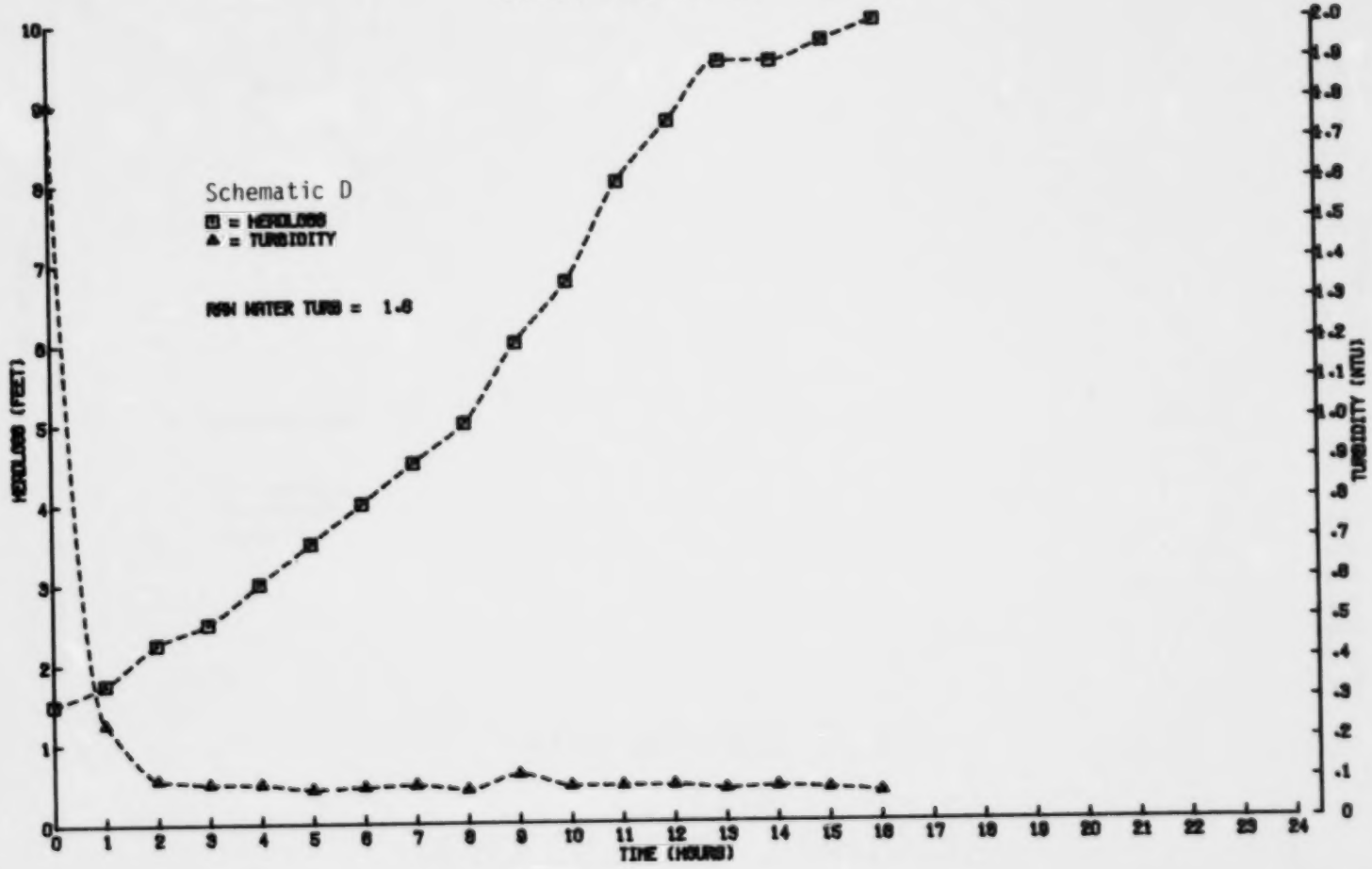
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 136M



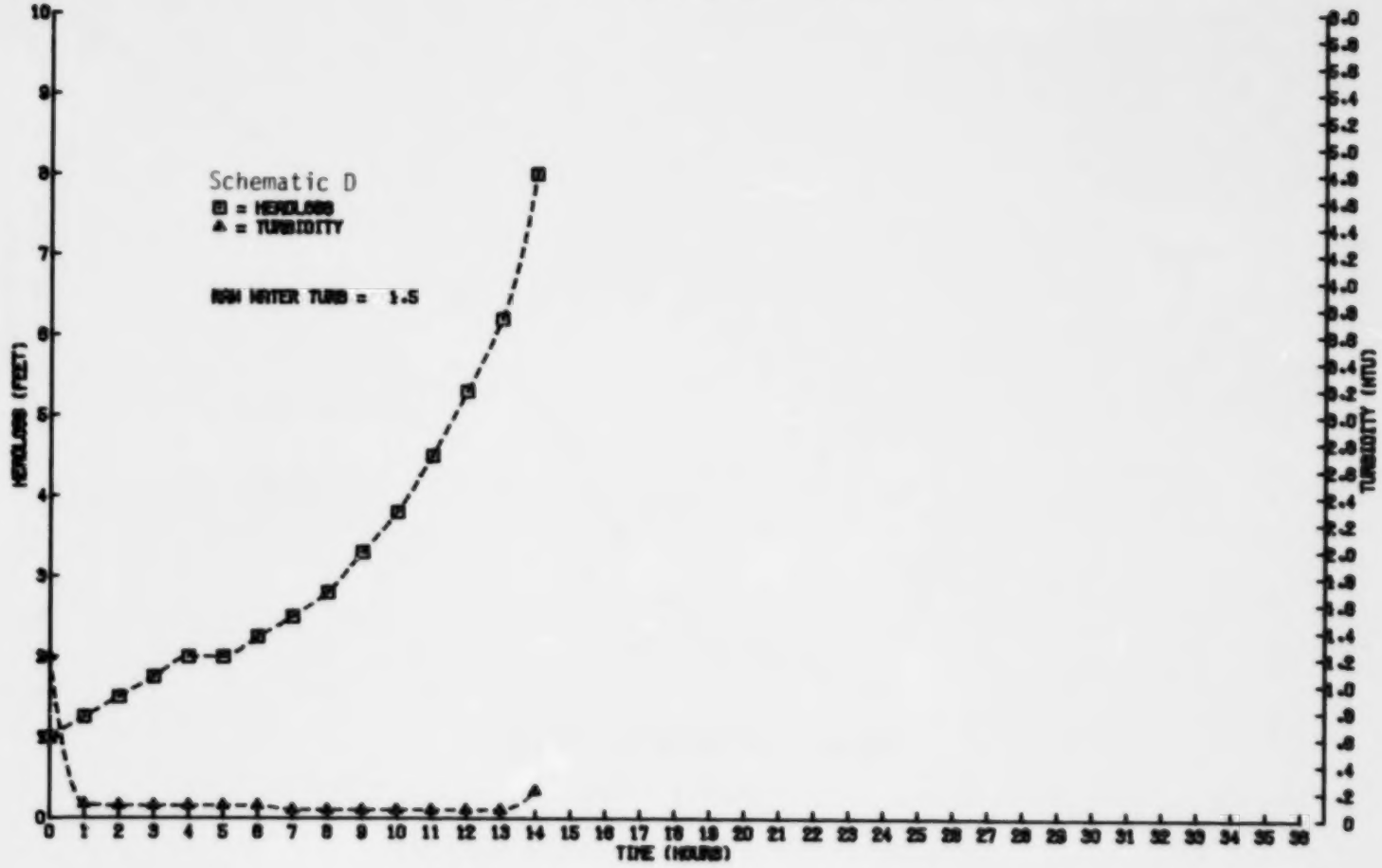
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 137



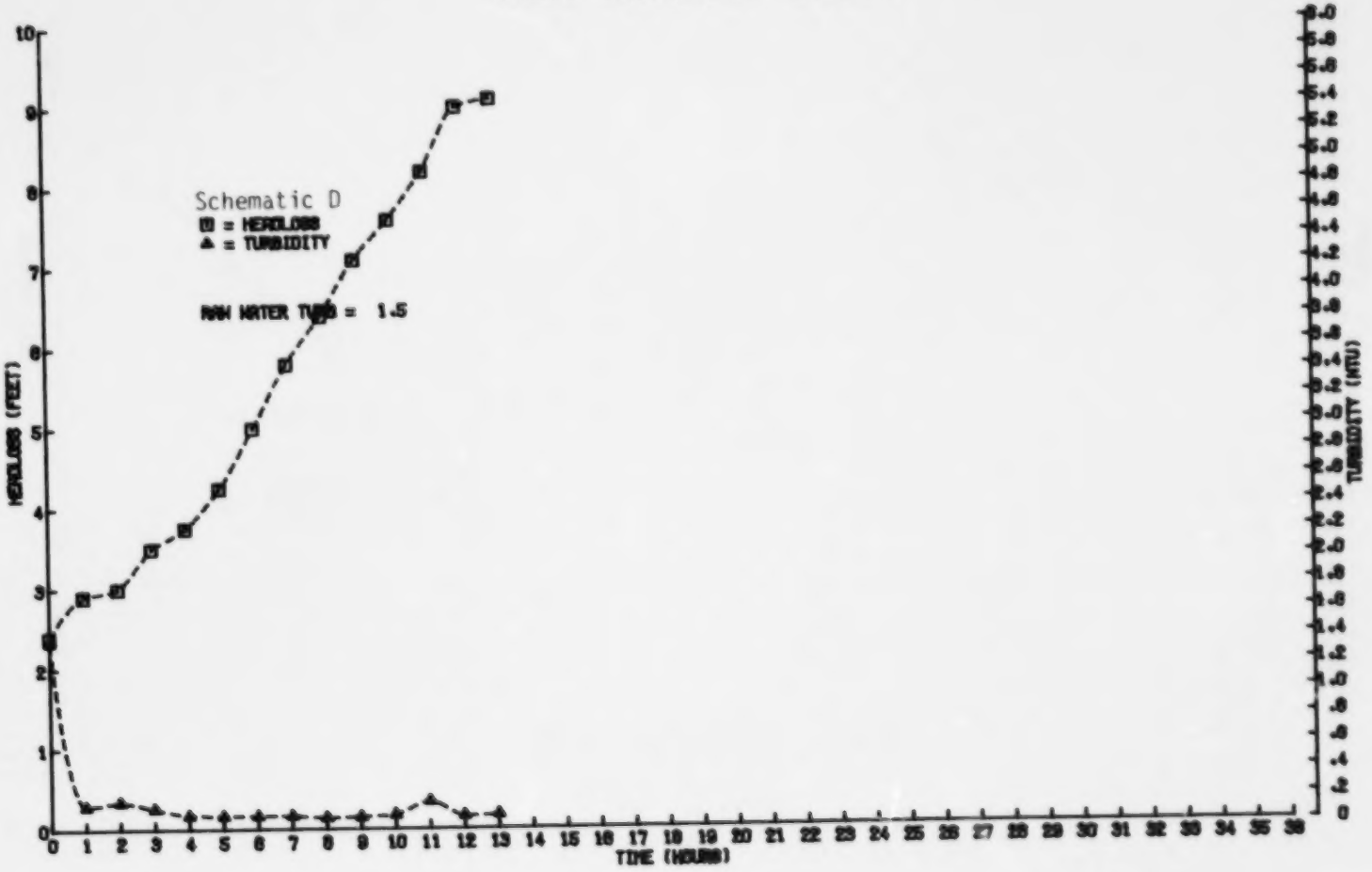
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 137M



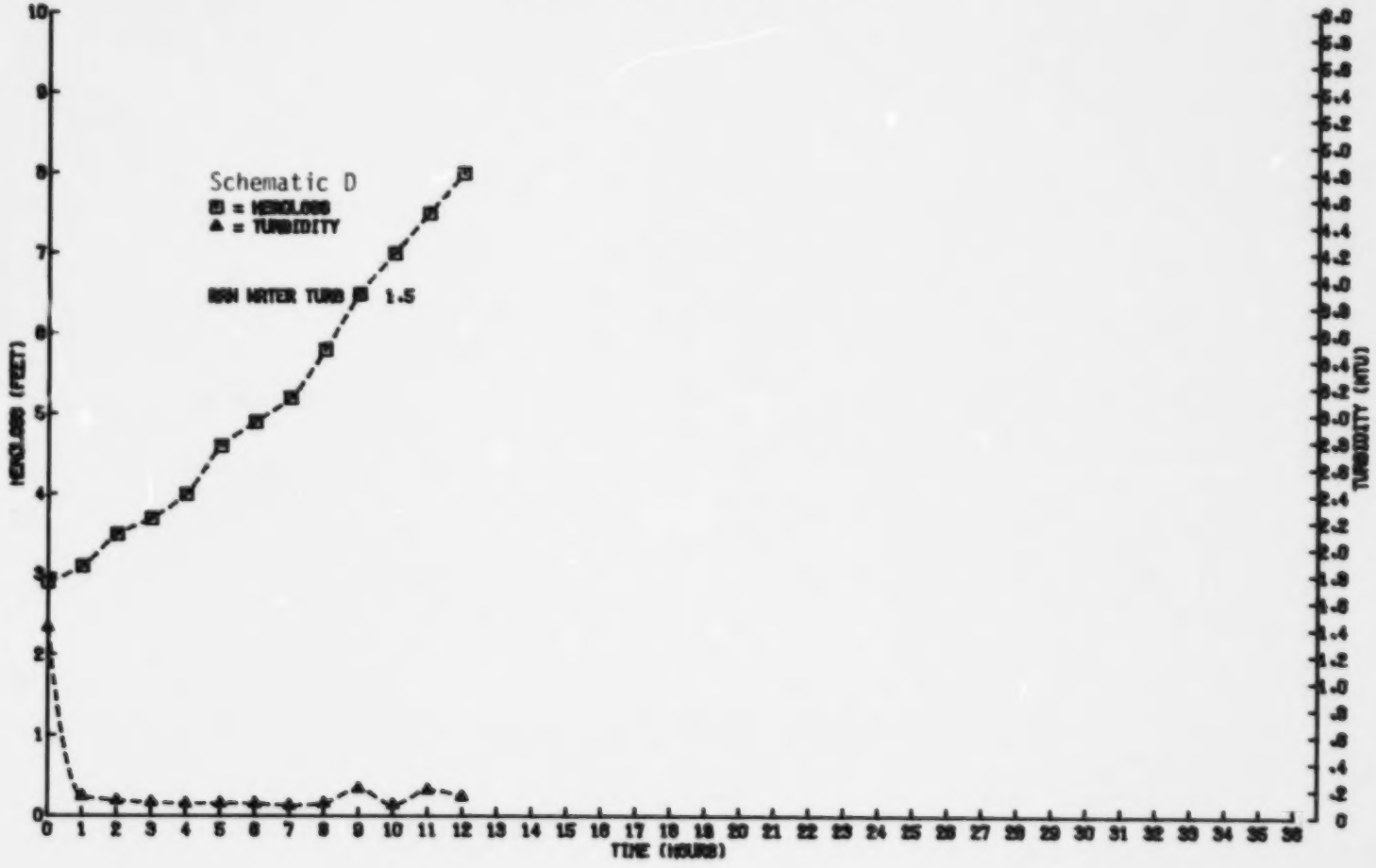
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 138



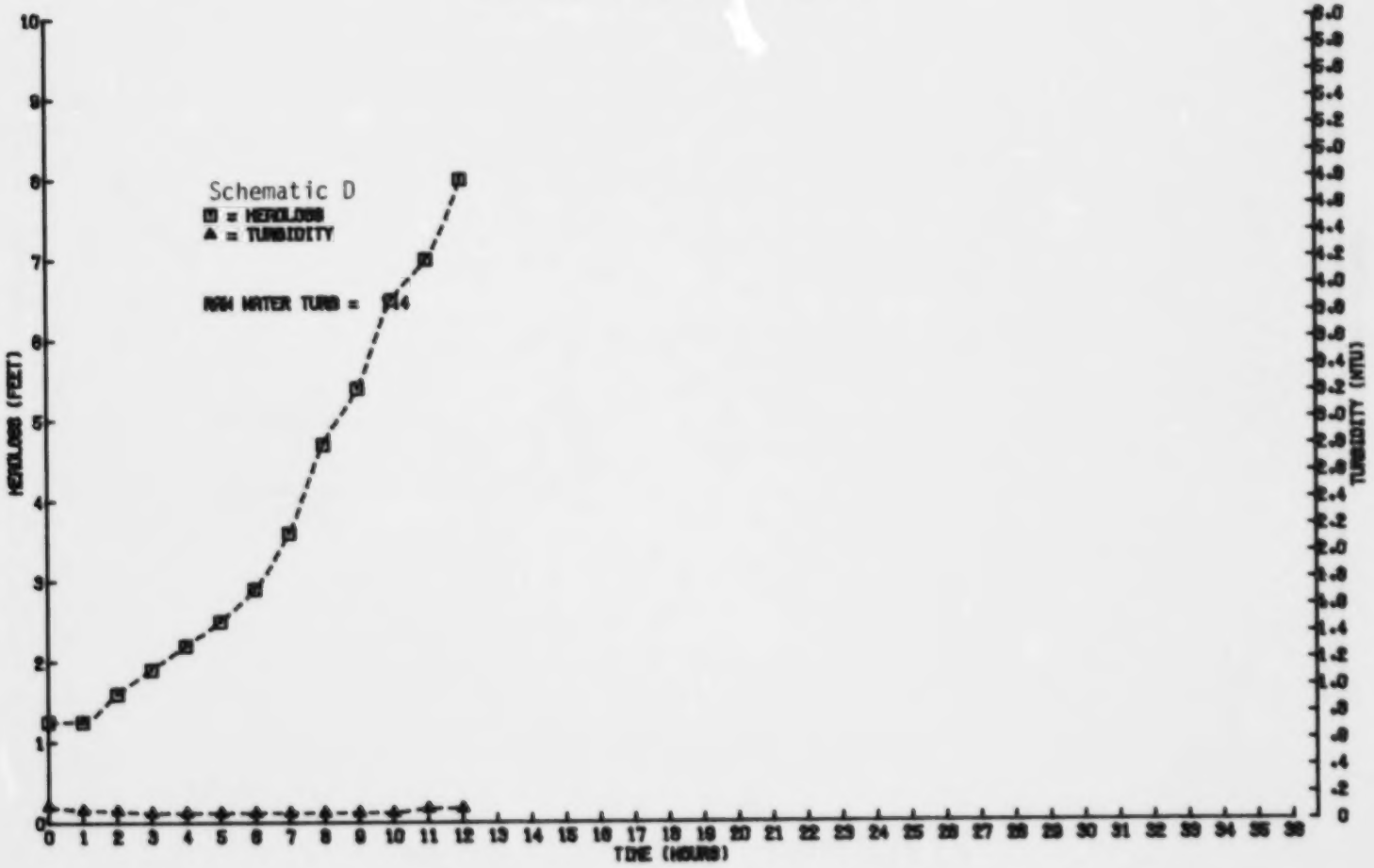
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 138M



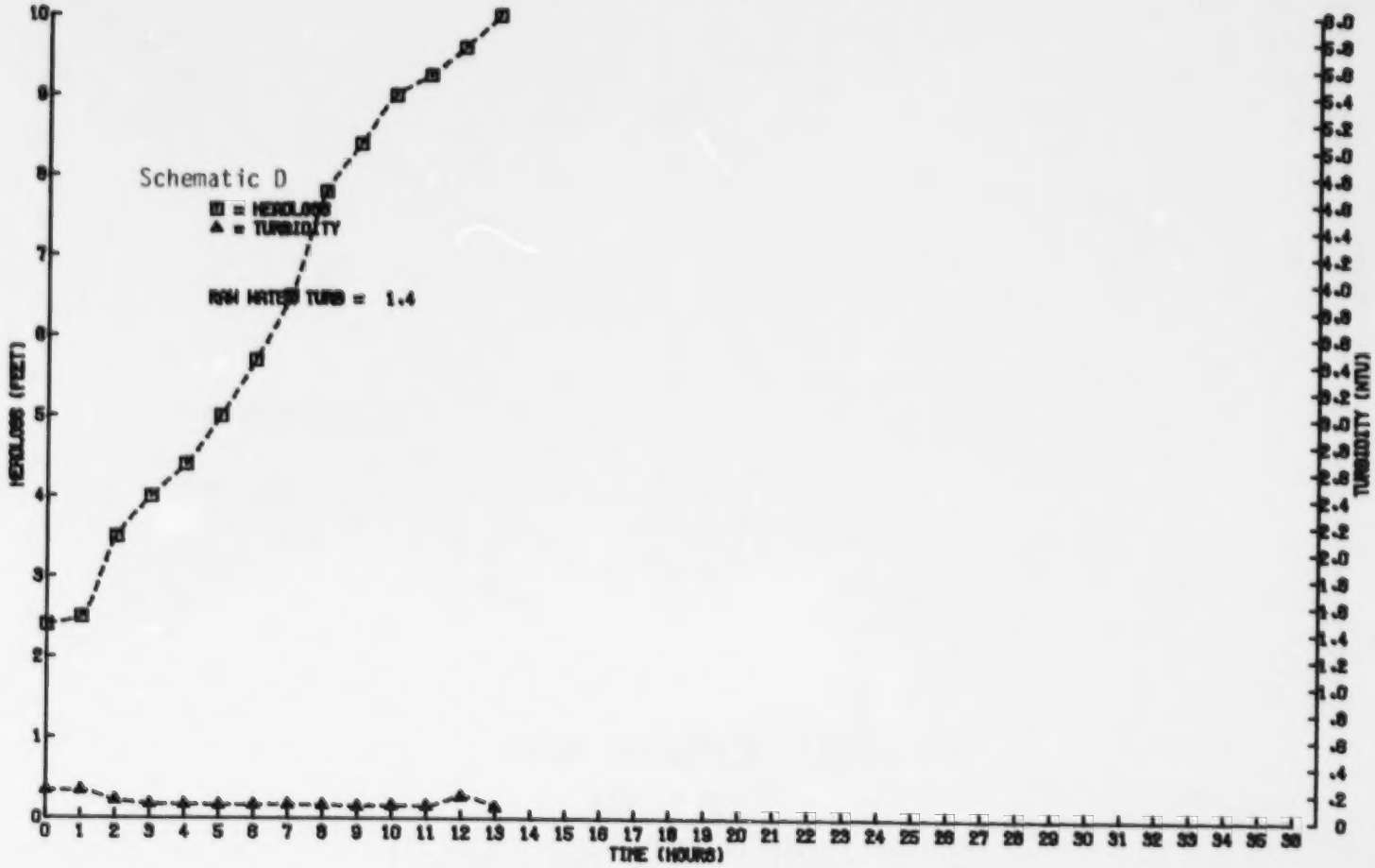
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 138F



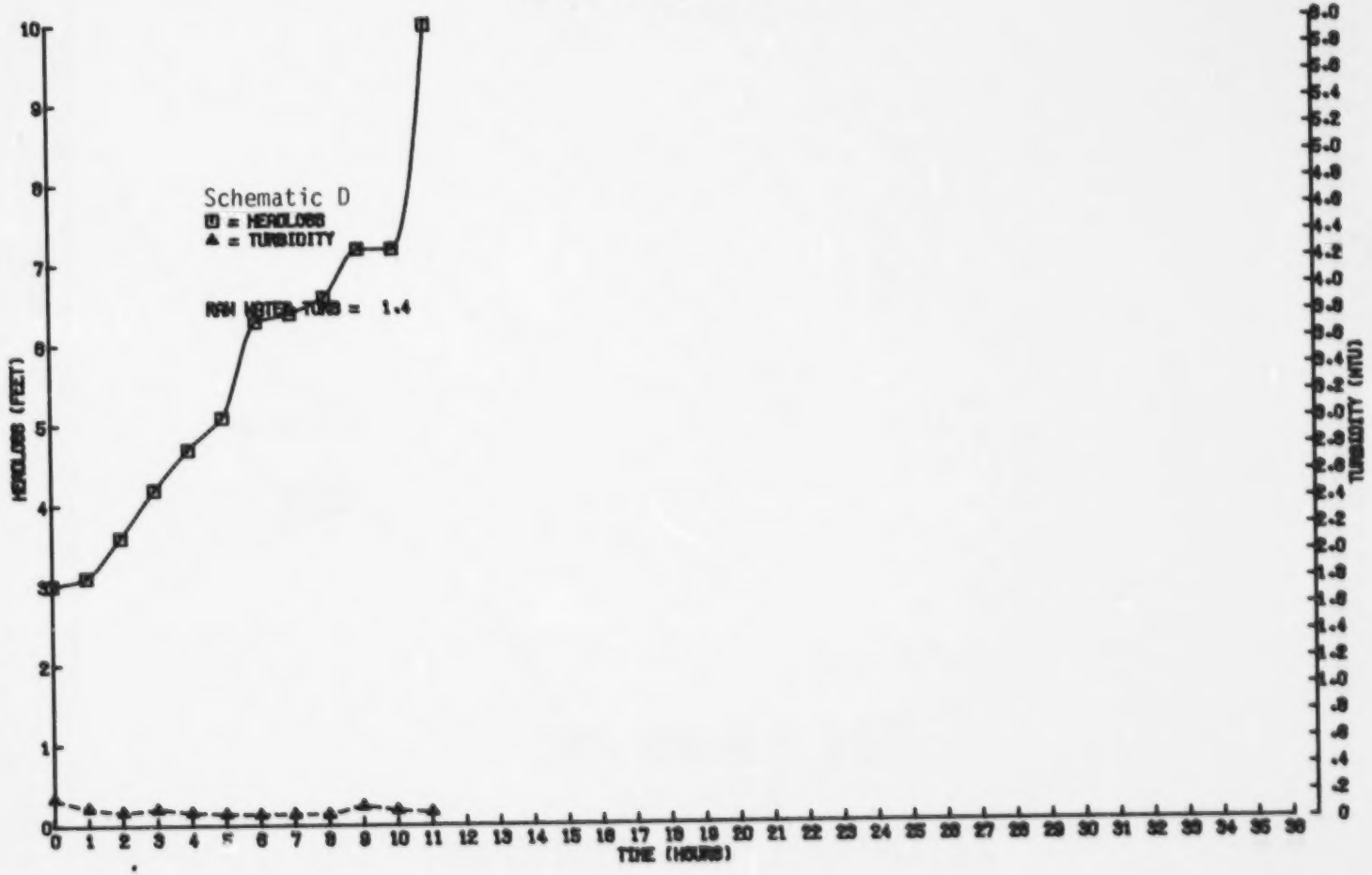
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 139



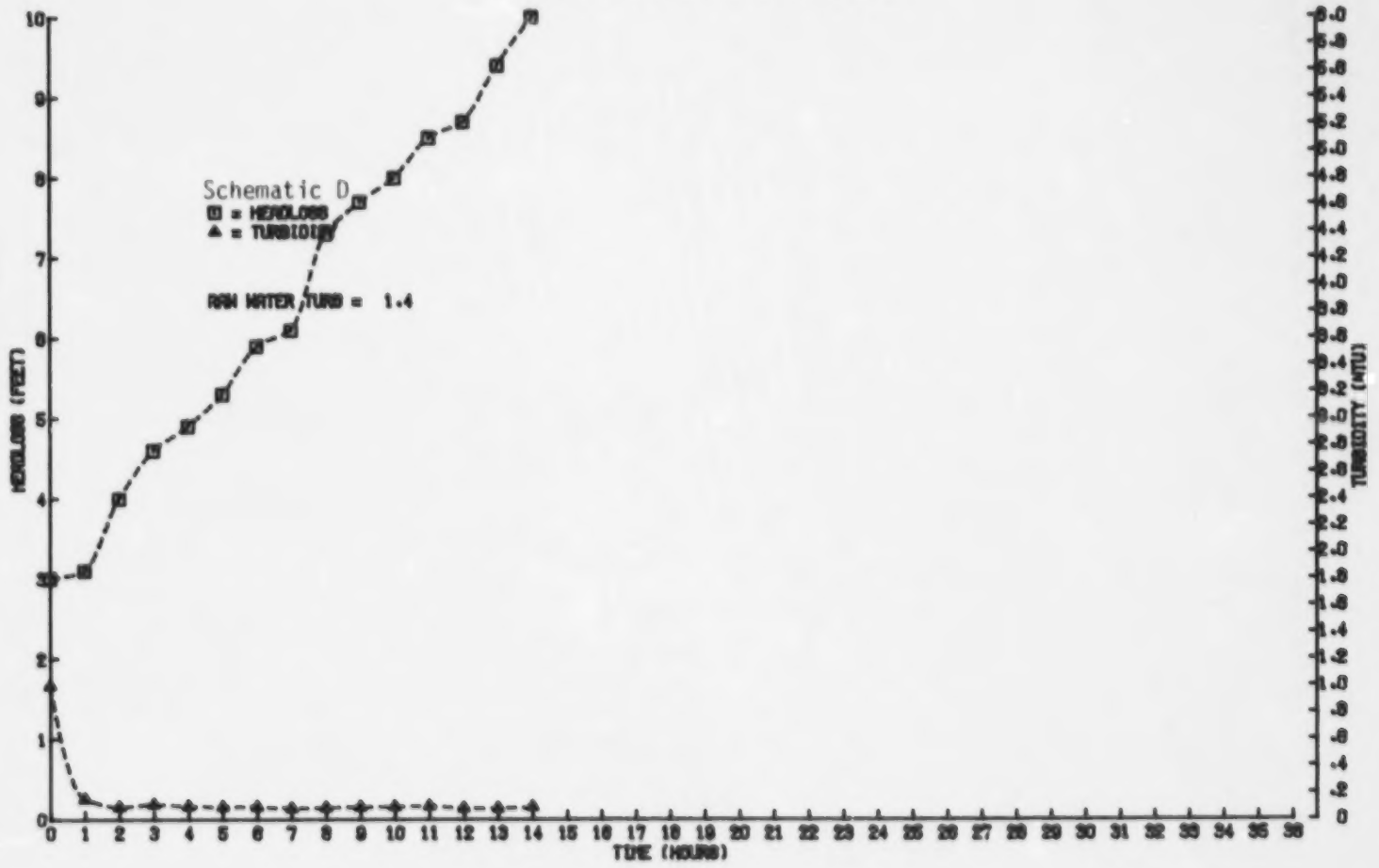
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 139M



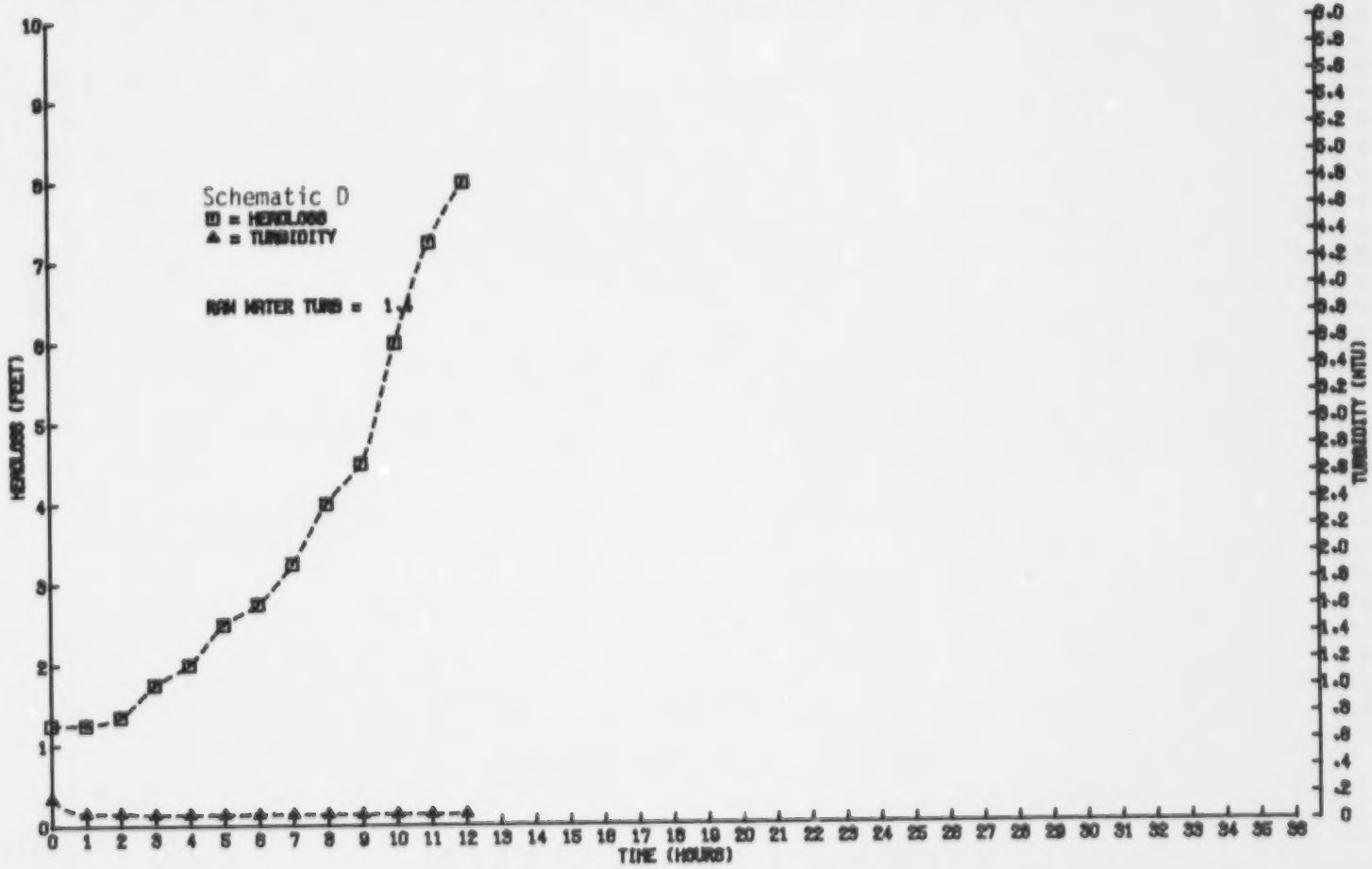
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 139F



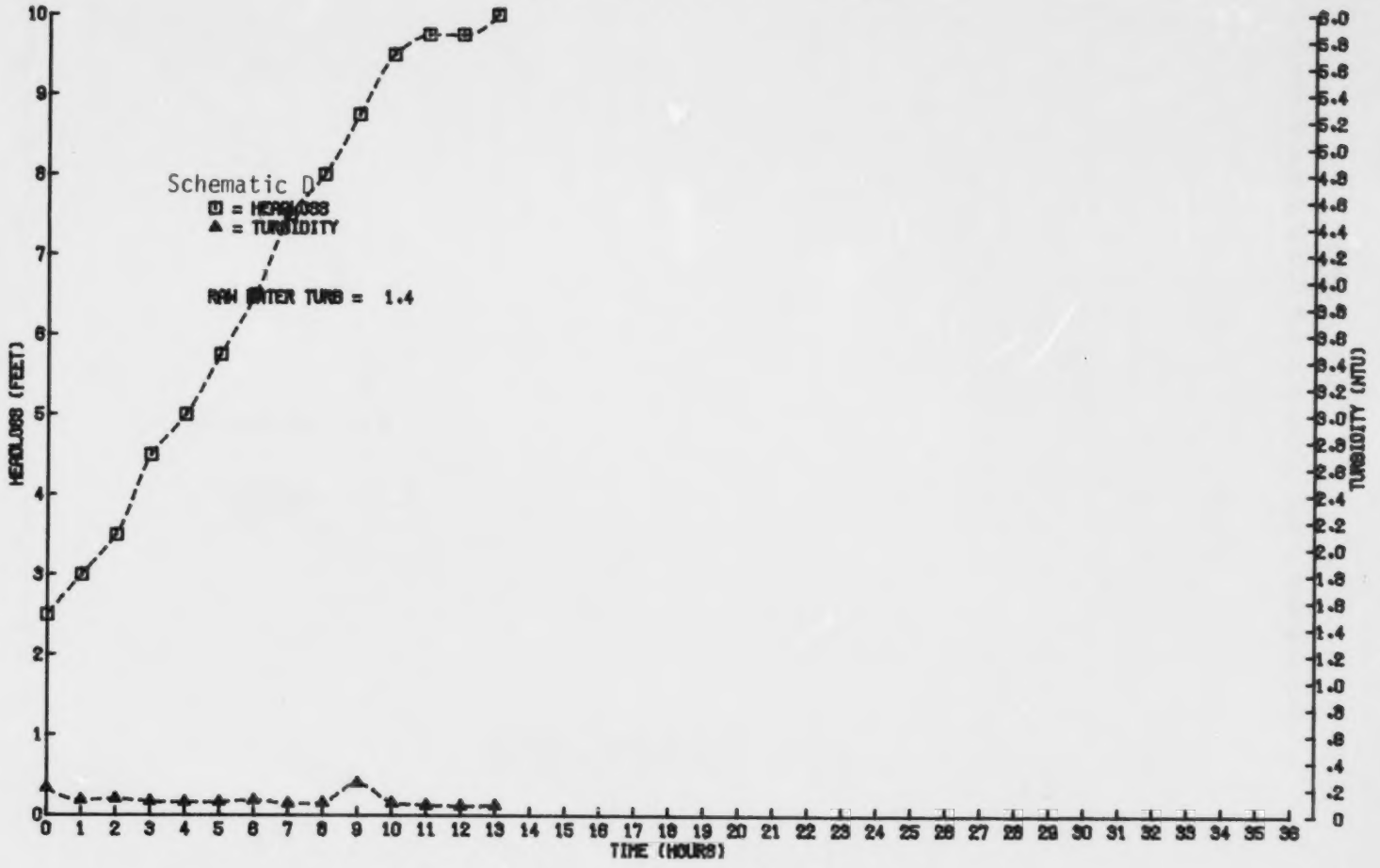
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 139C



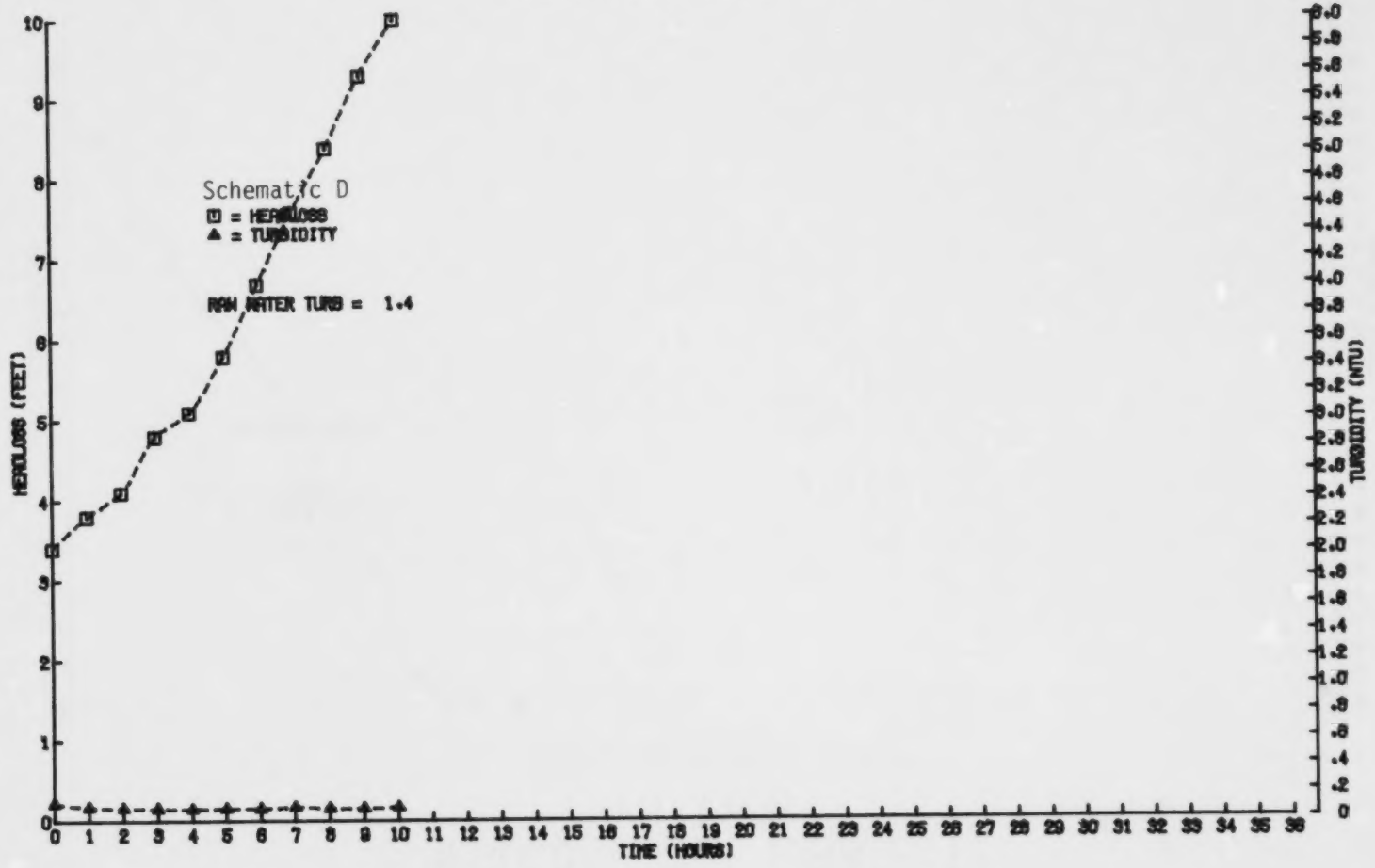
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 140



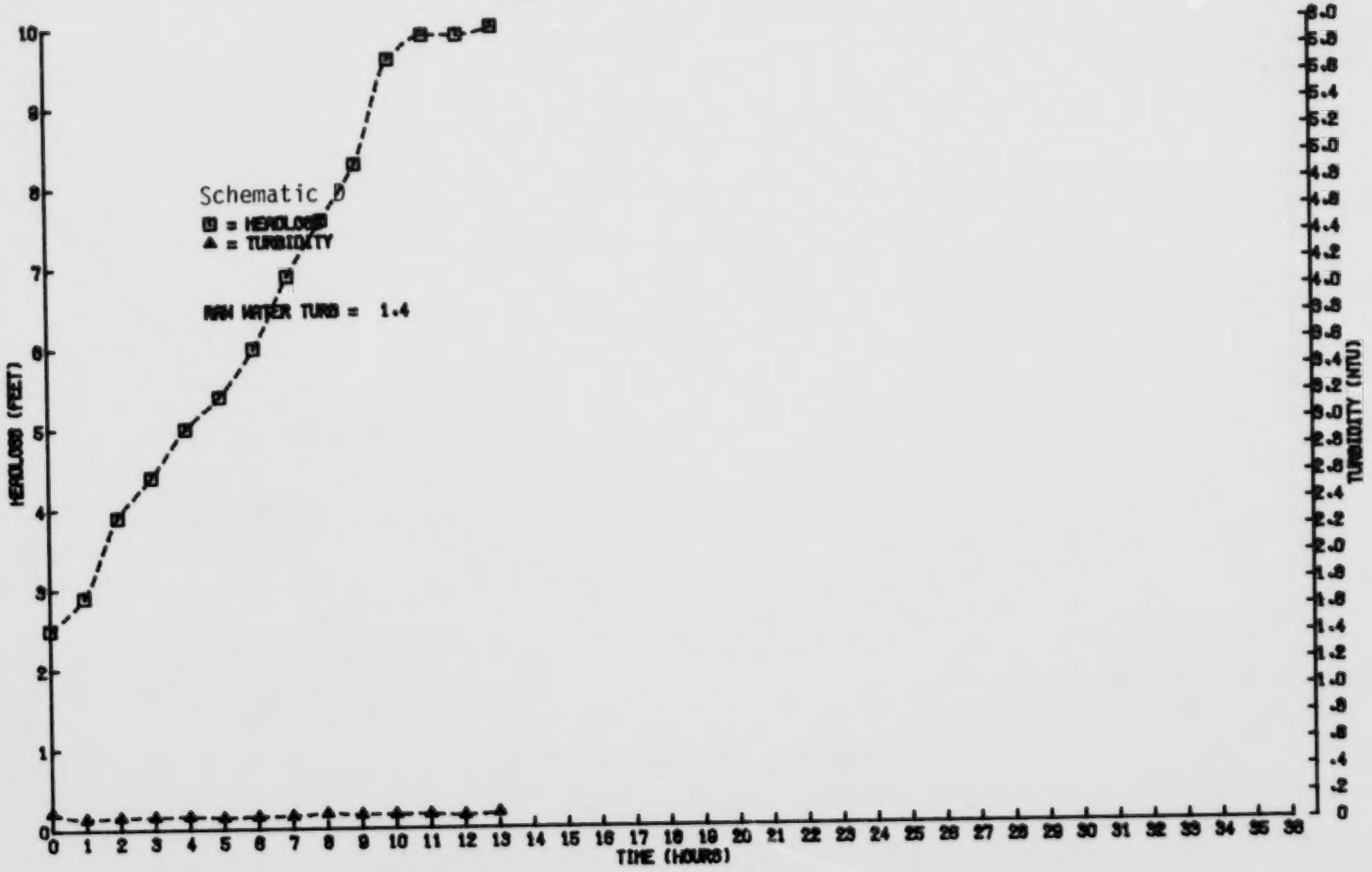
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 140M



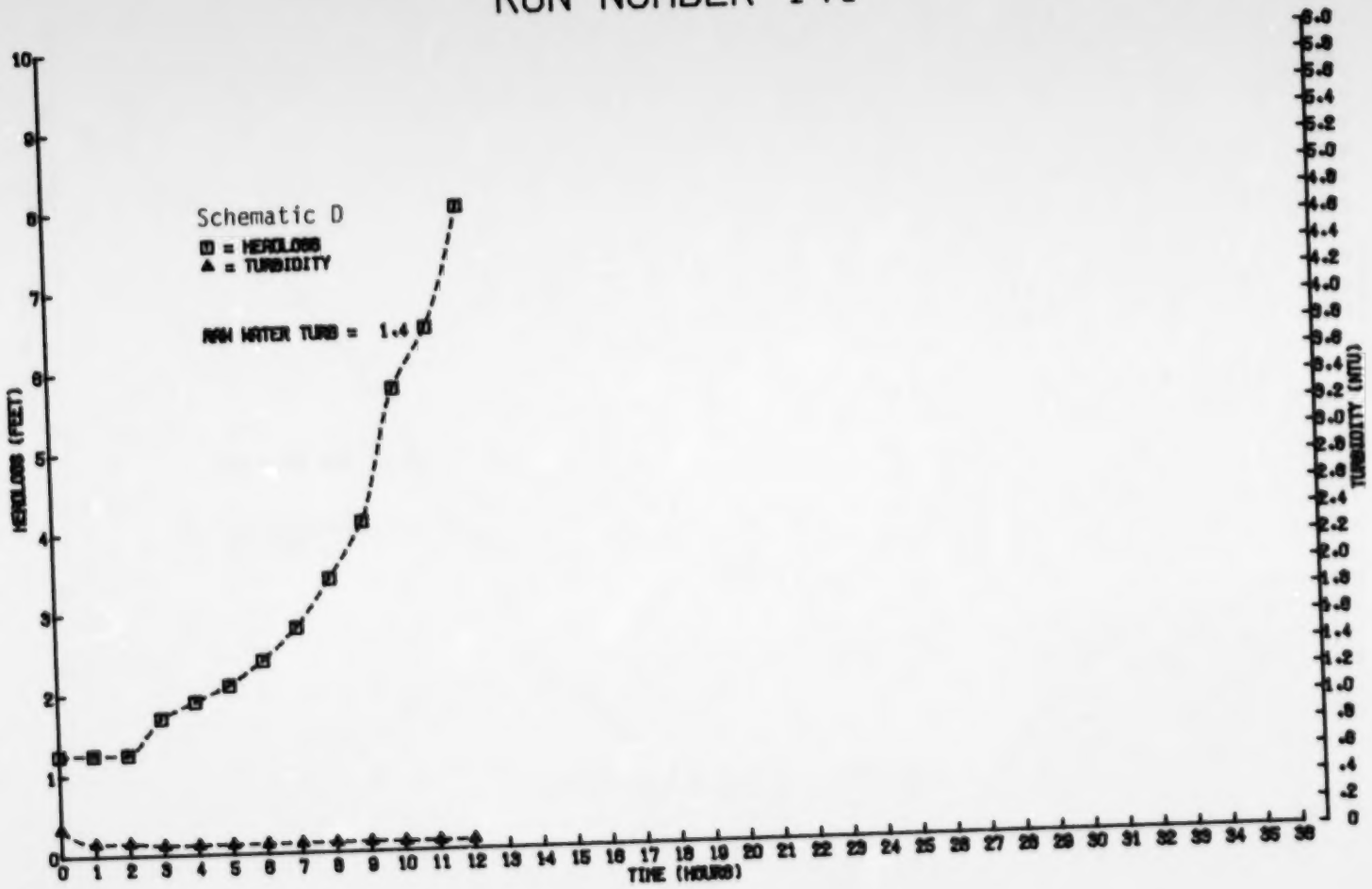
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 140F



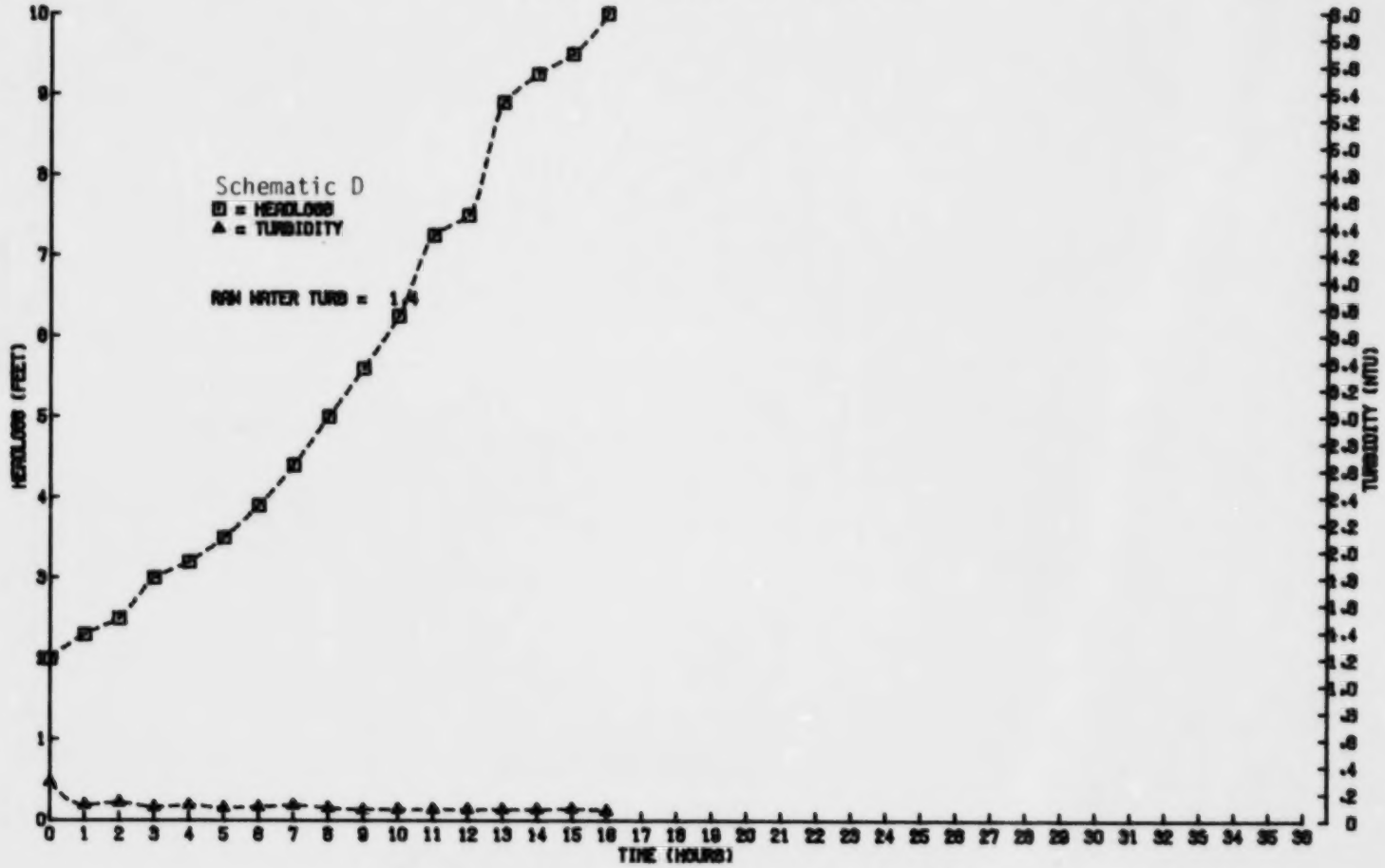
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 140C



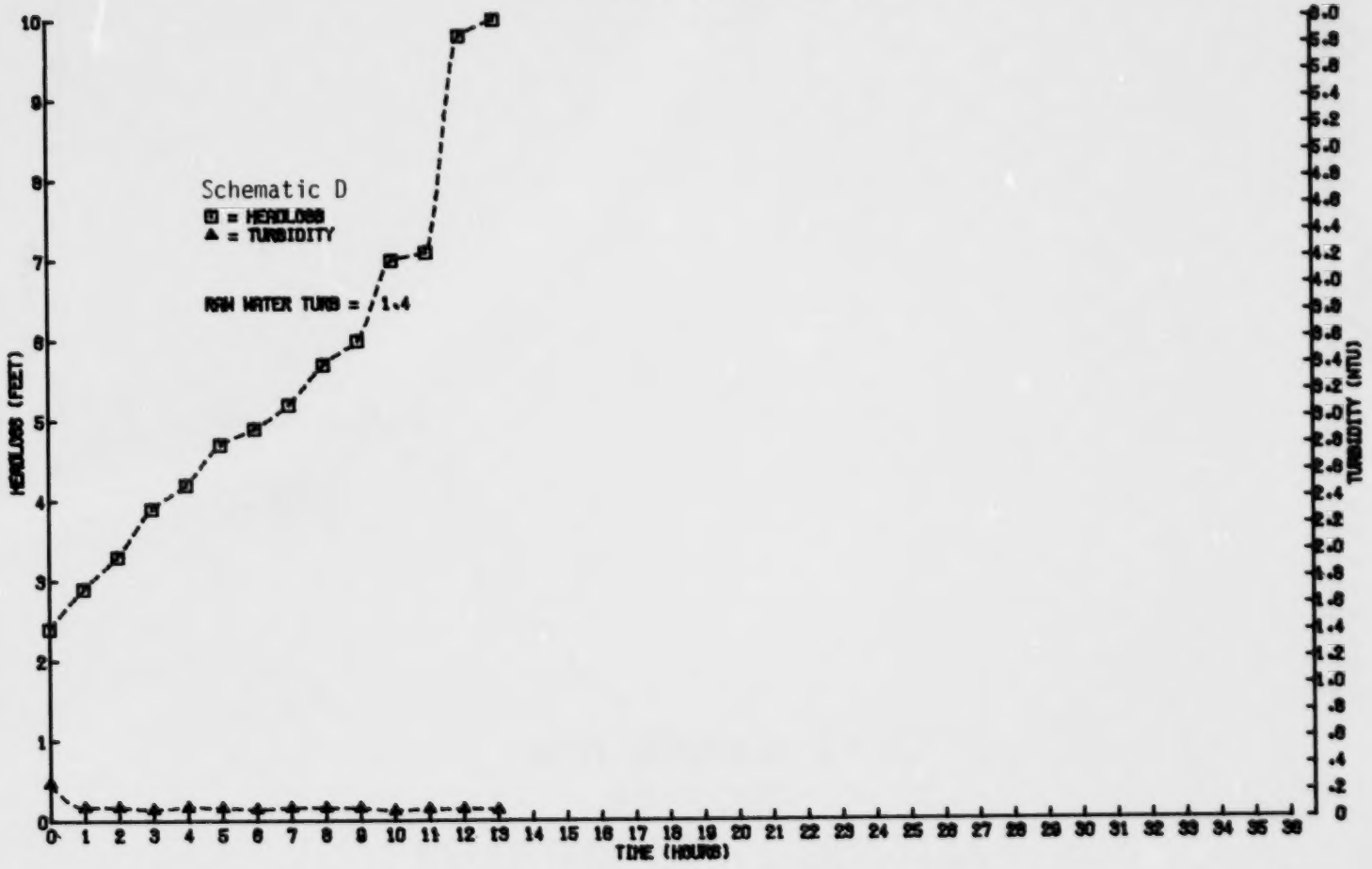
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 141



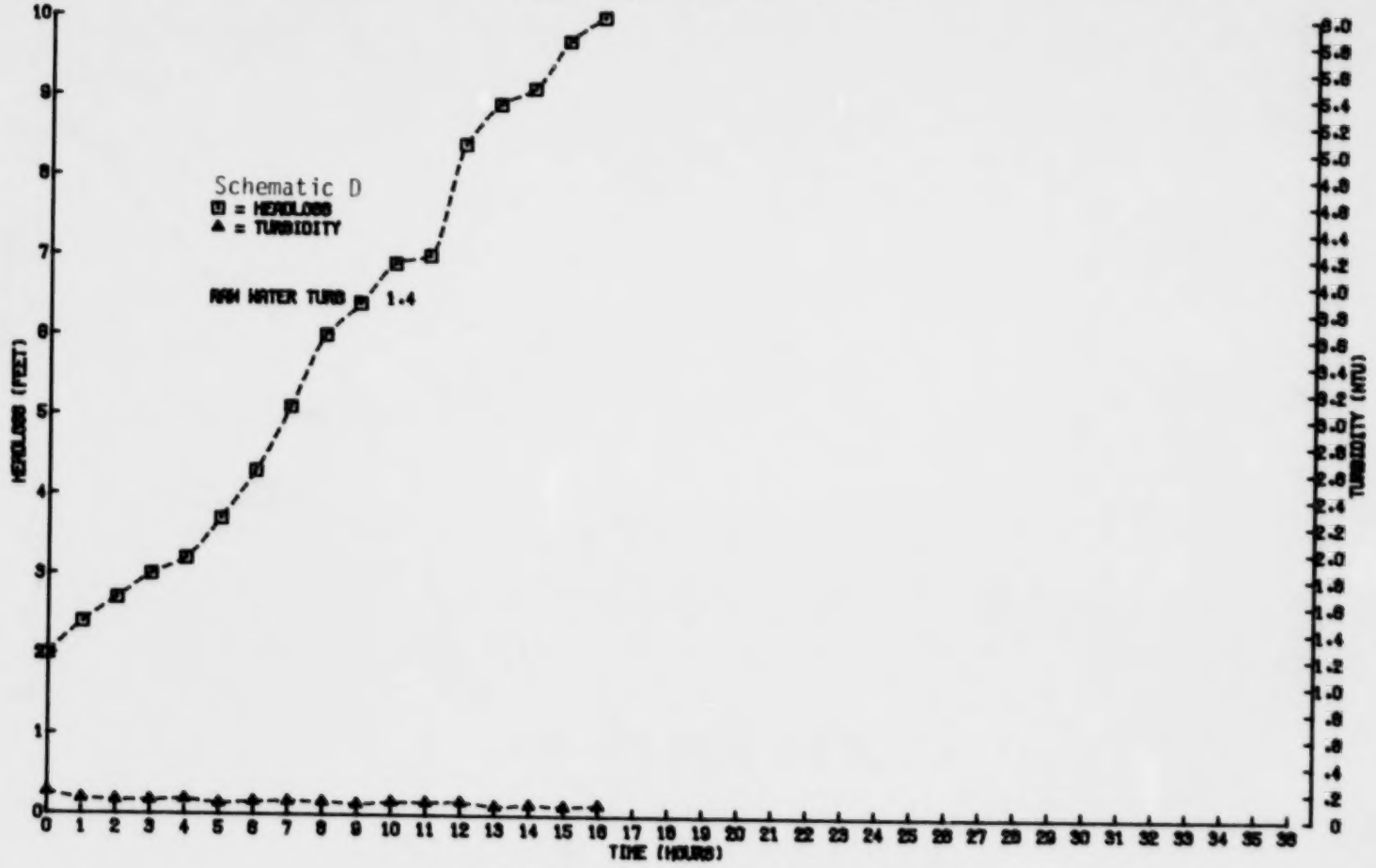
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 141M



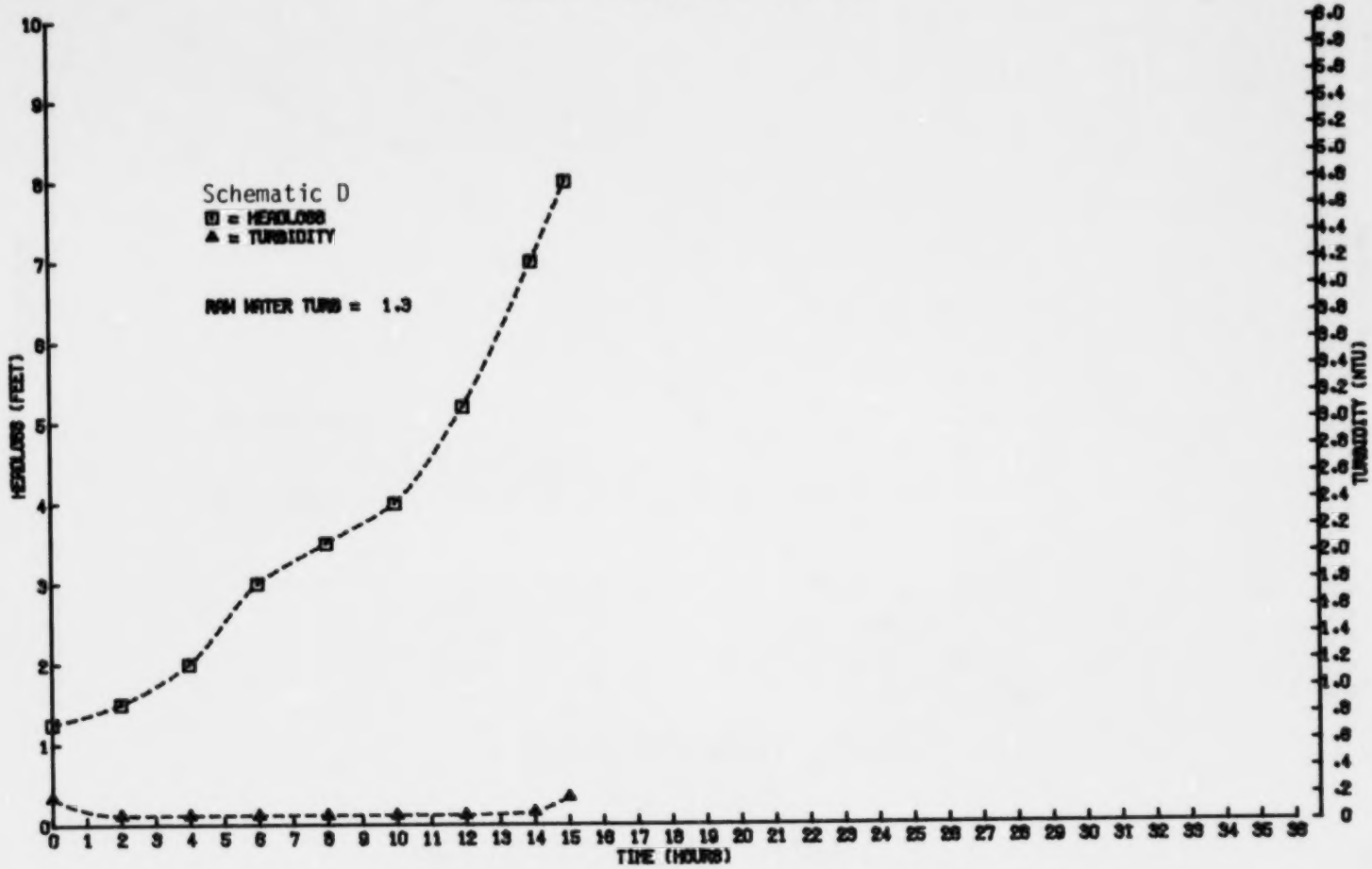
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 141F



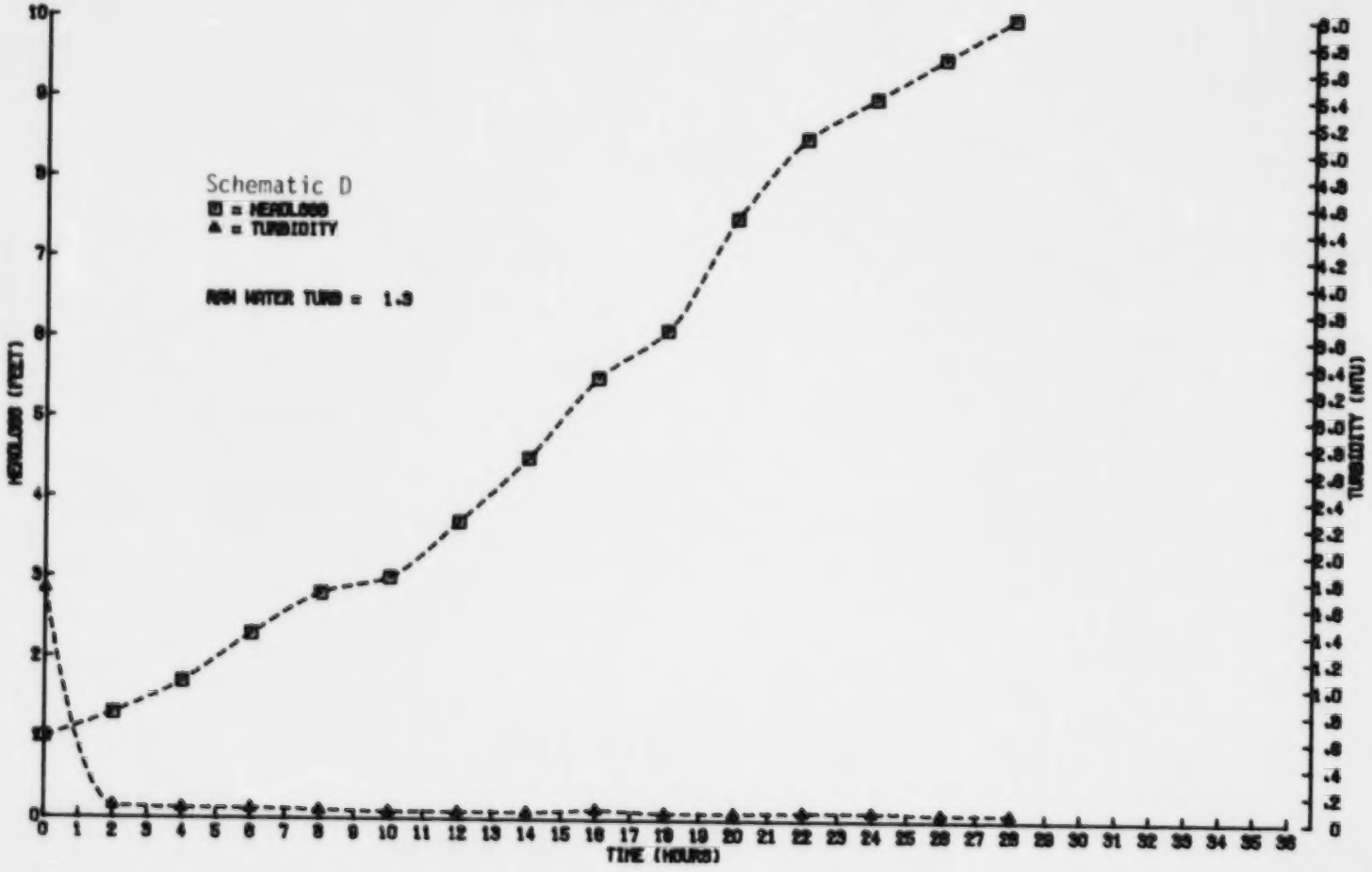
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 141C



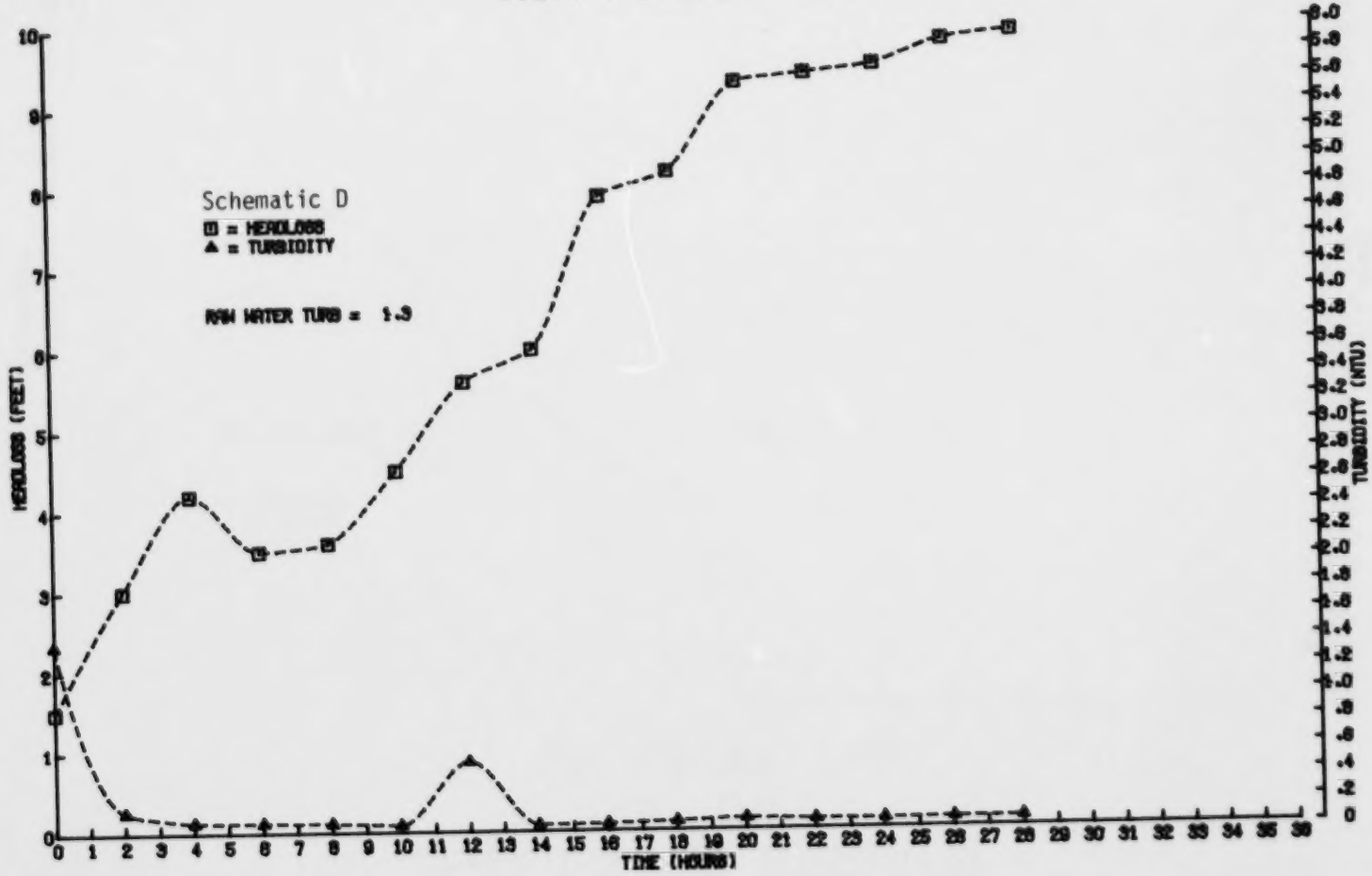
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 142



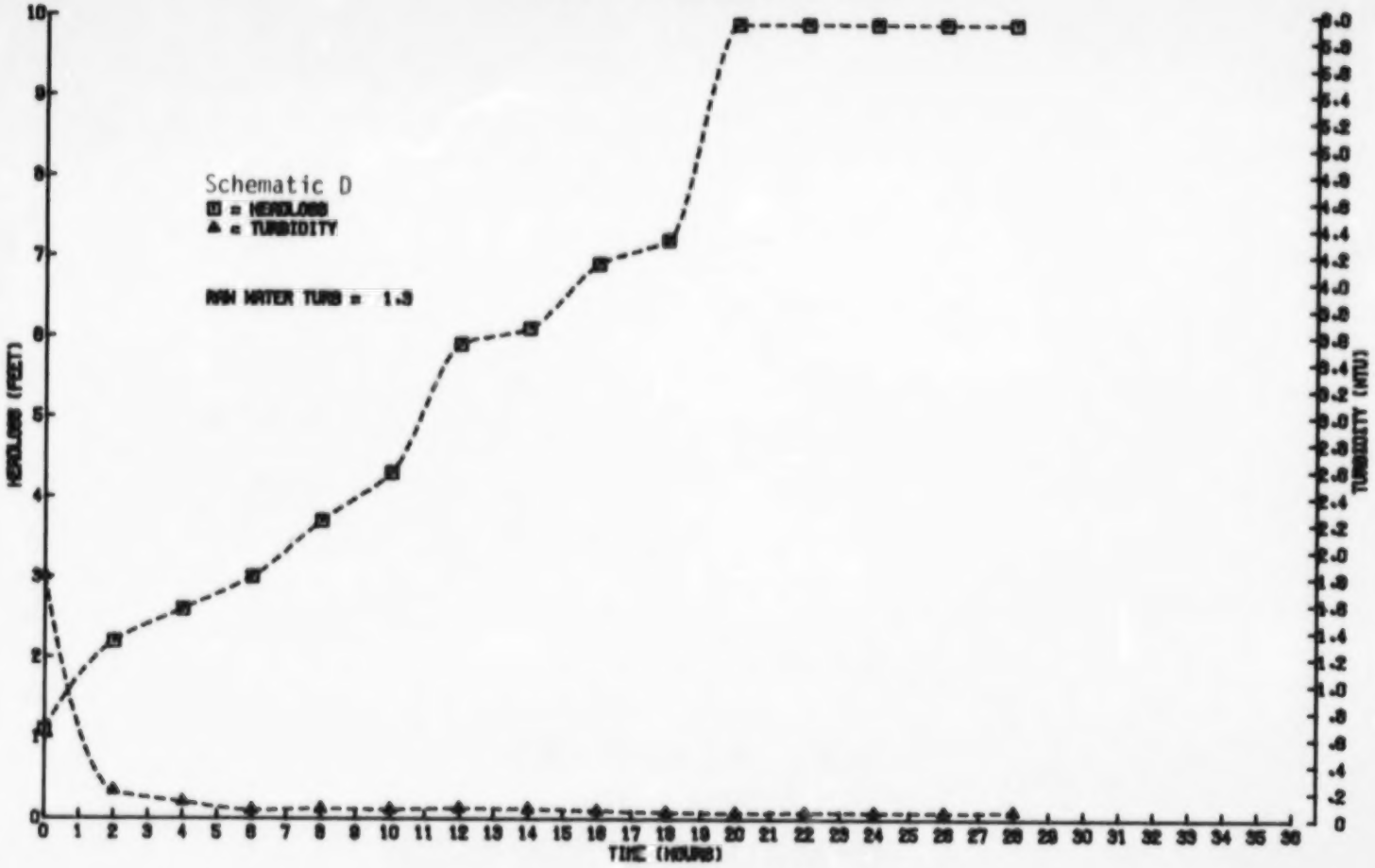
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 142M



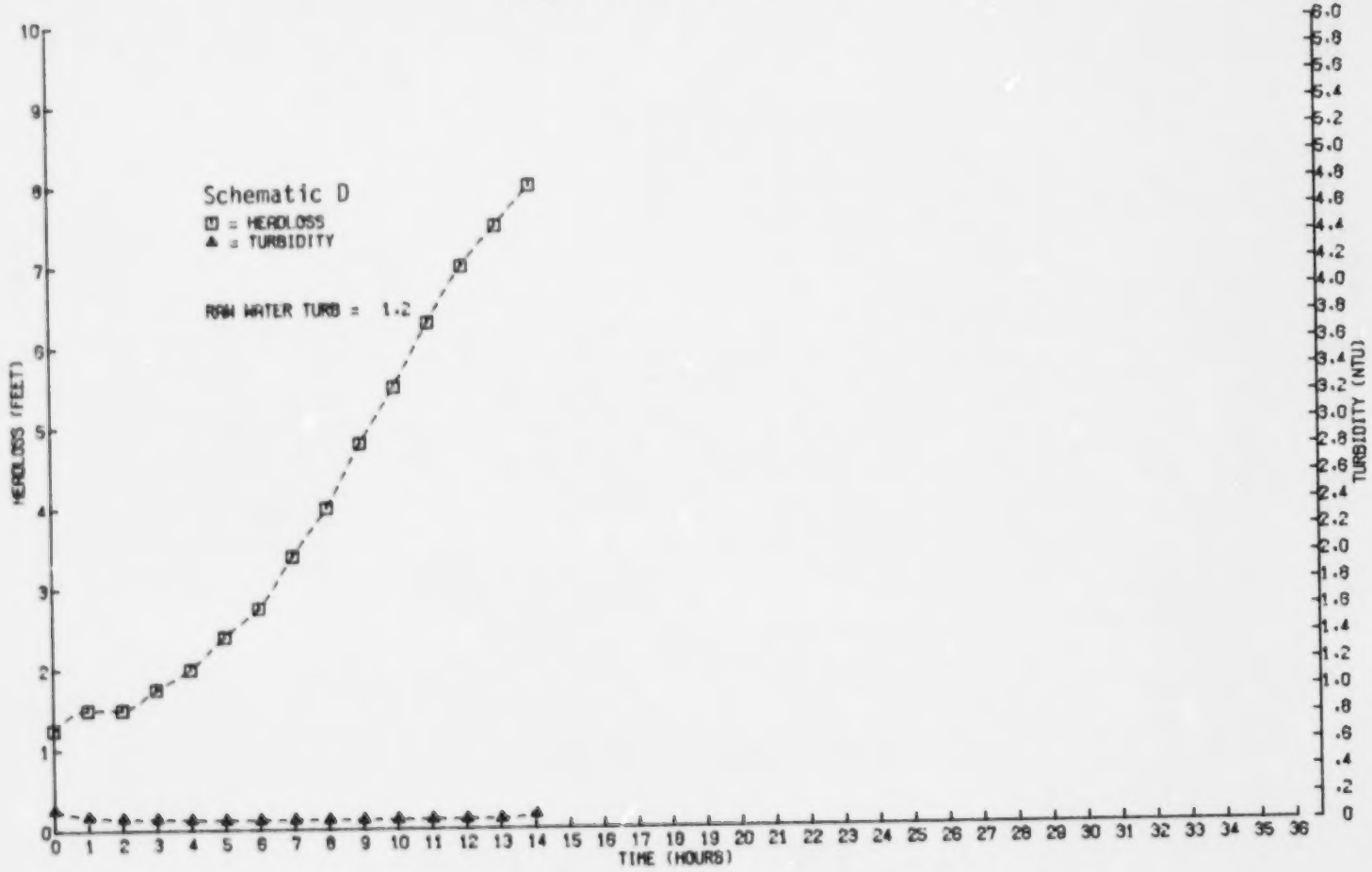
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 142F



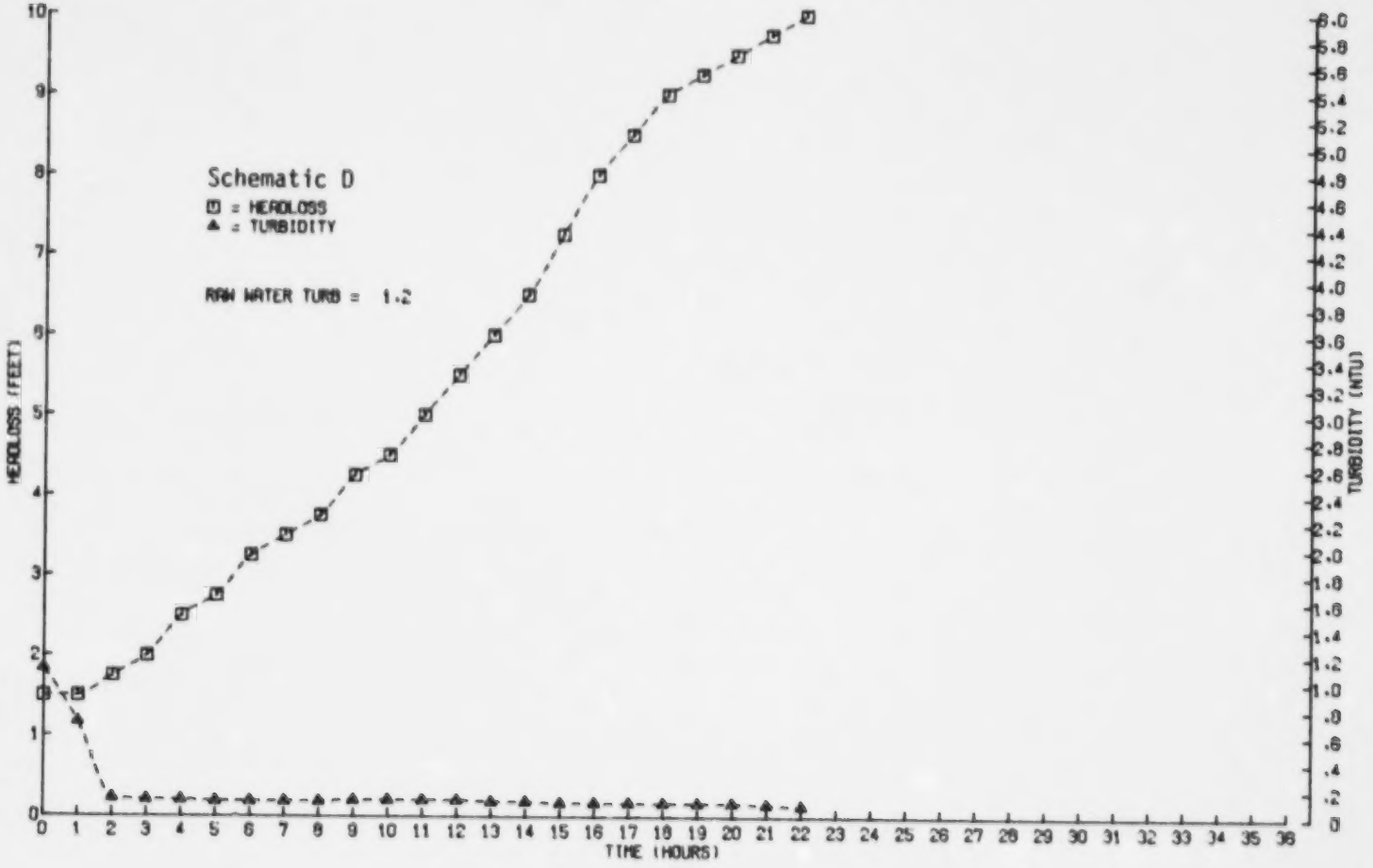
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 142C



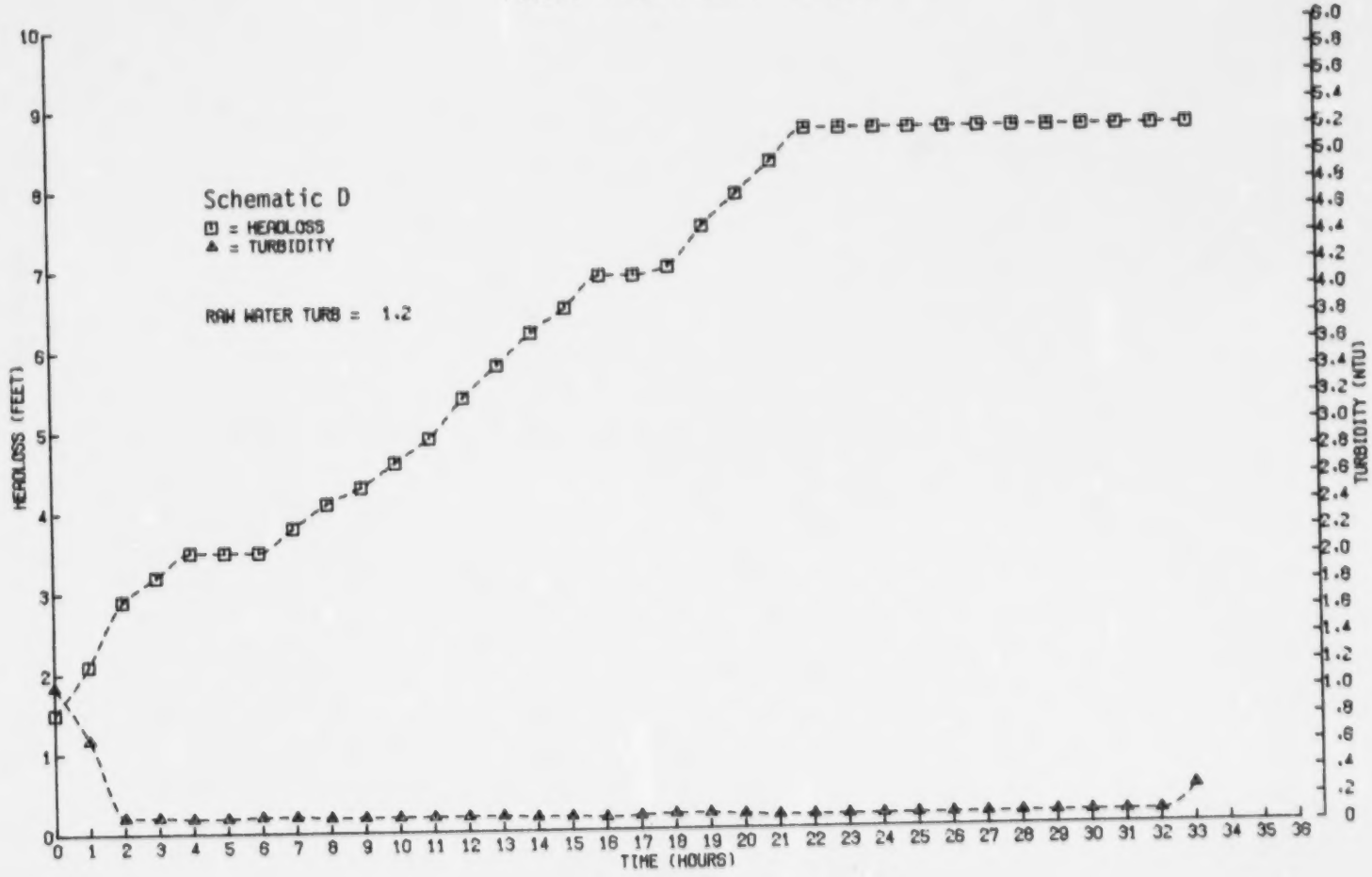
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 143



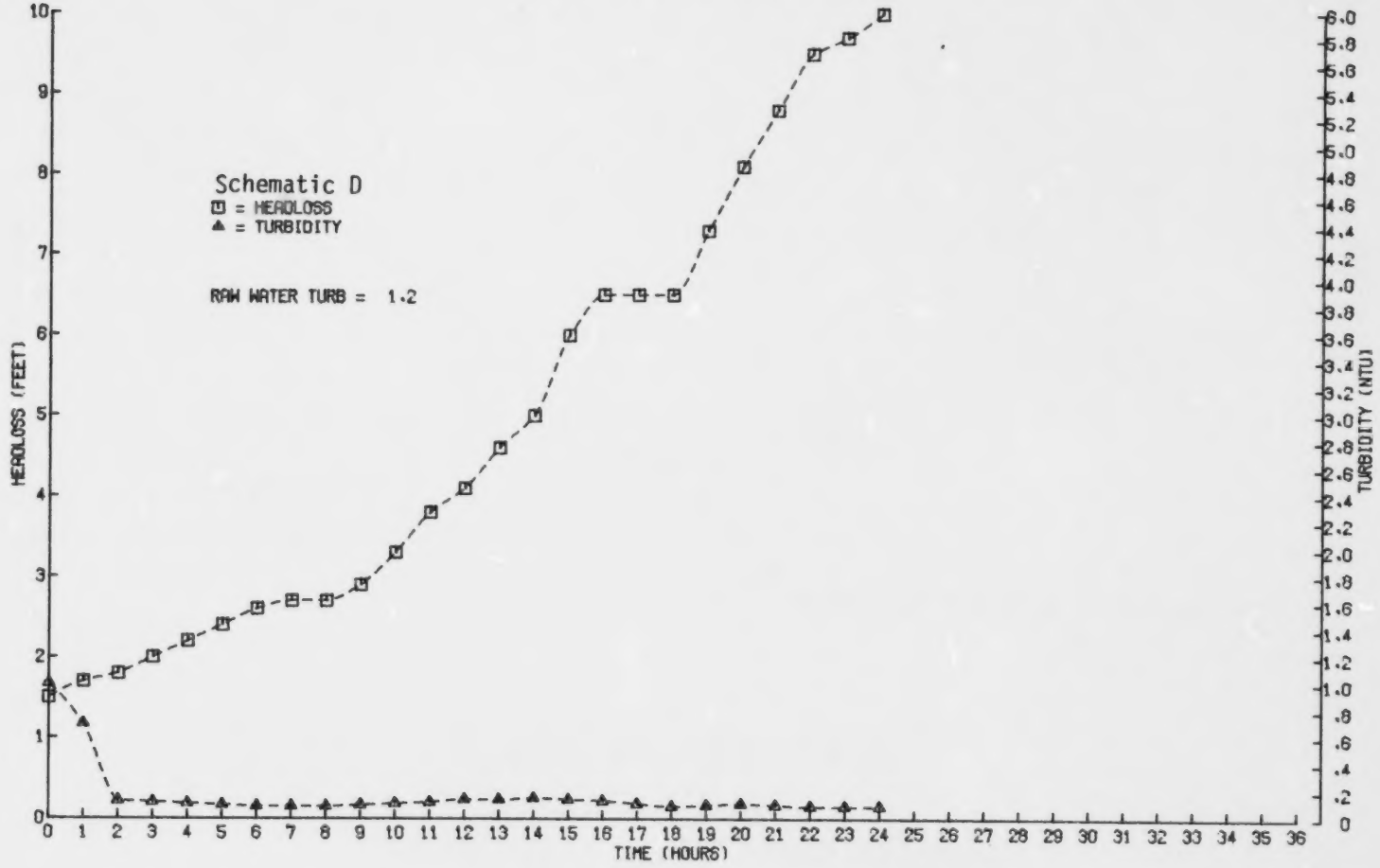
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 143M



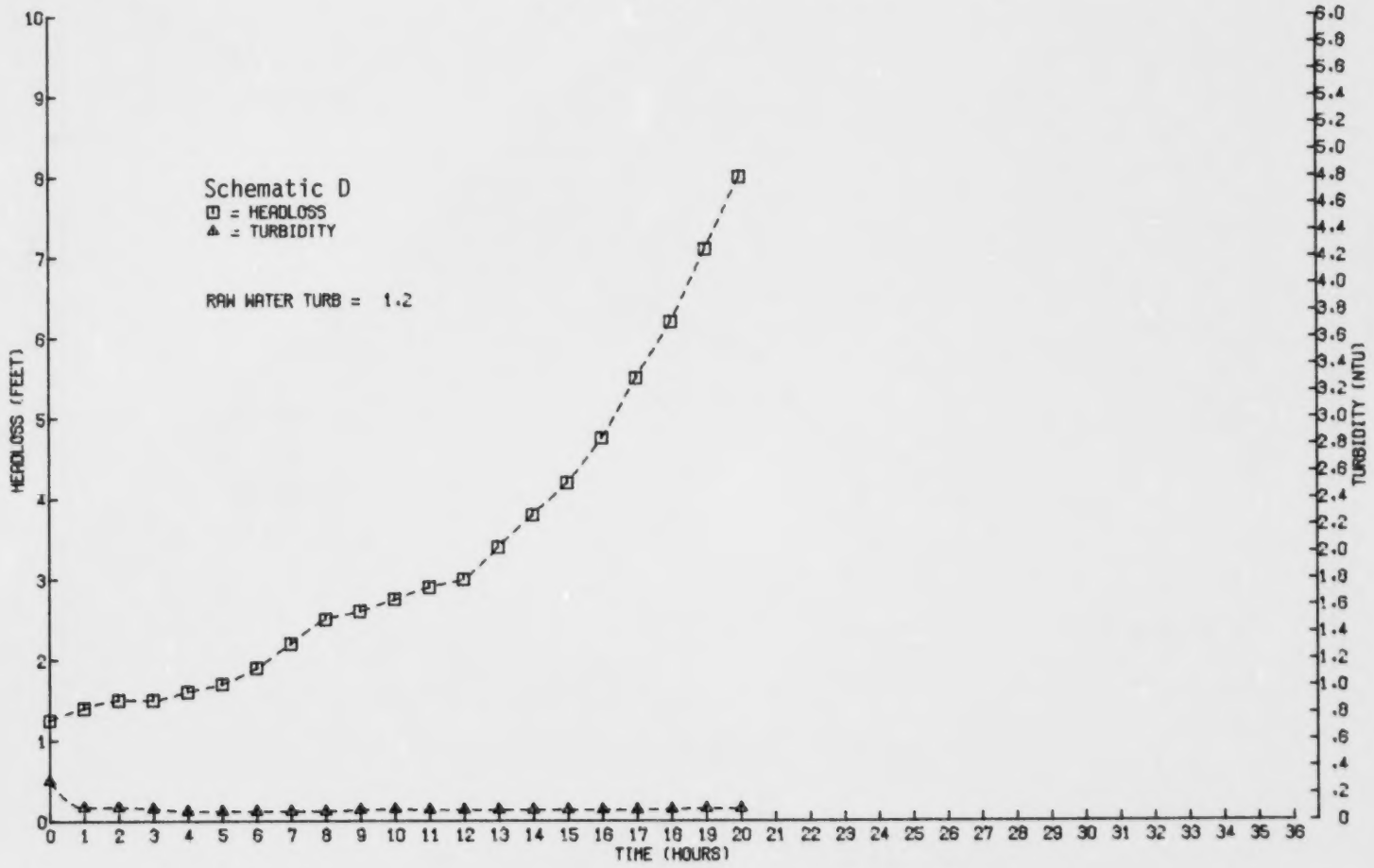
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 143F



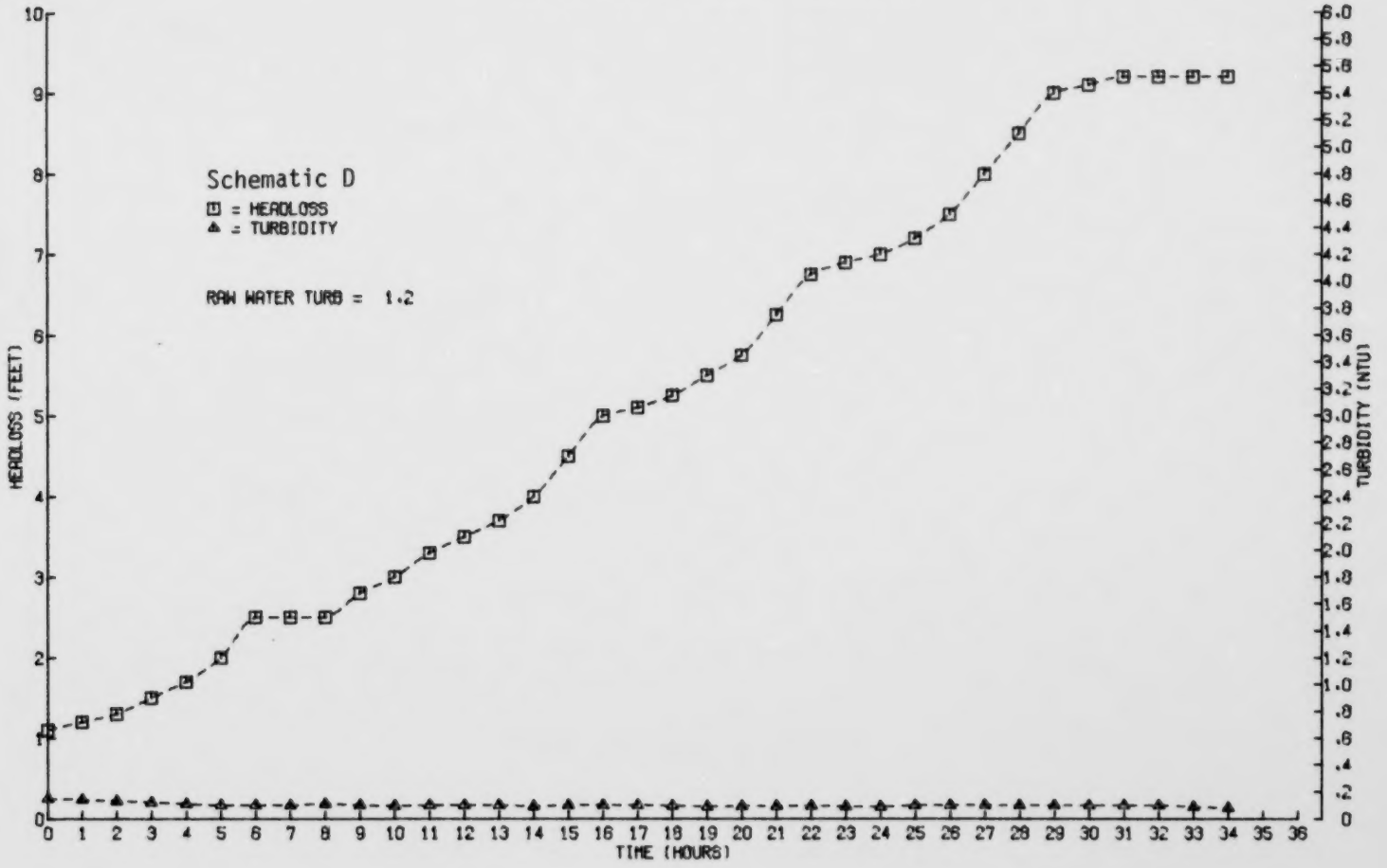
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 143C



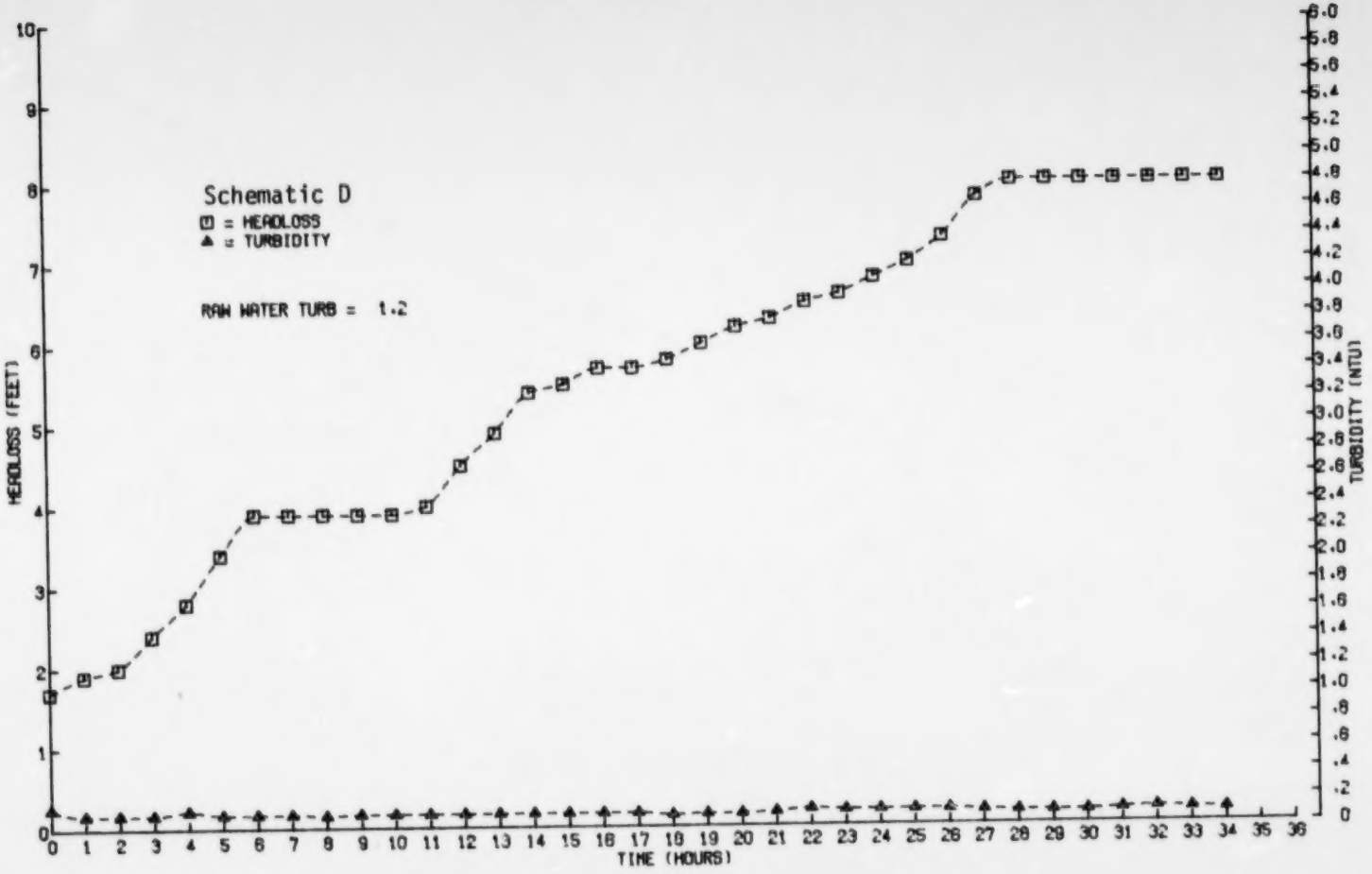
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 144



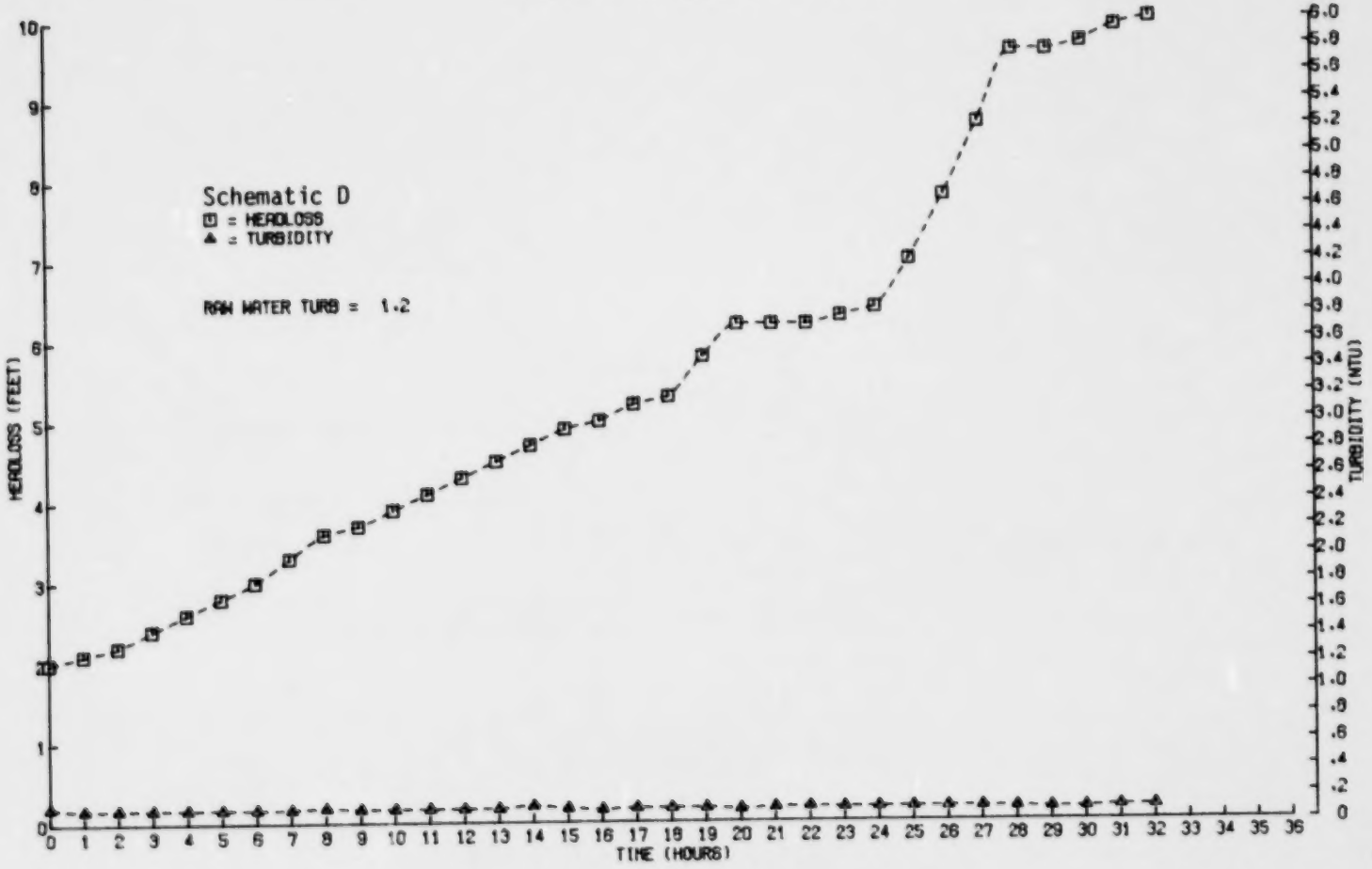
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 144M



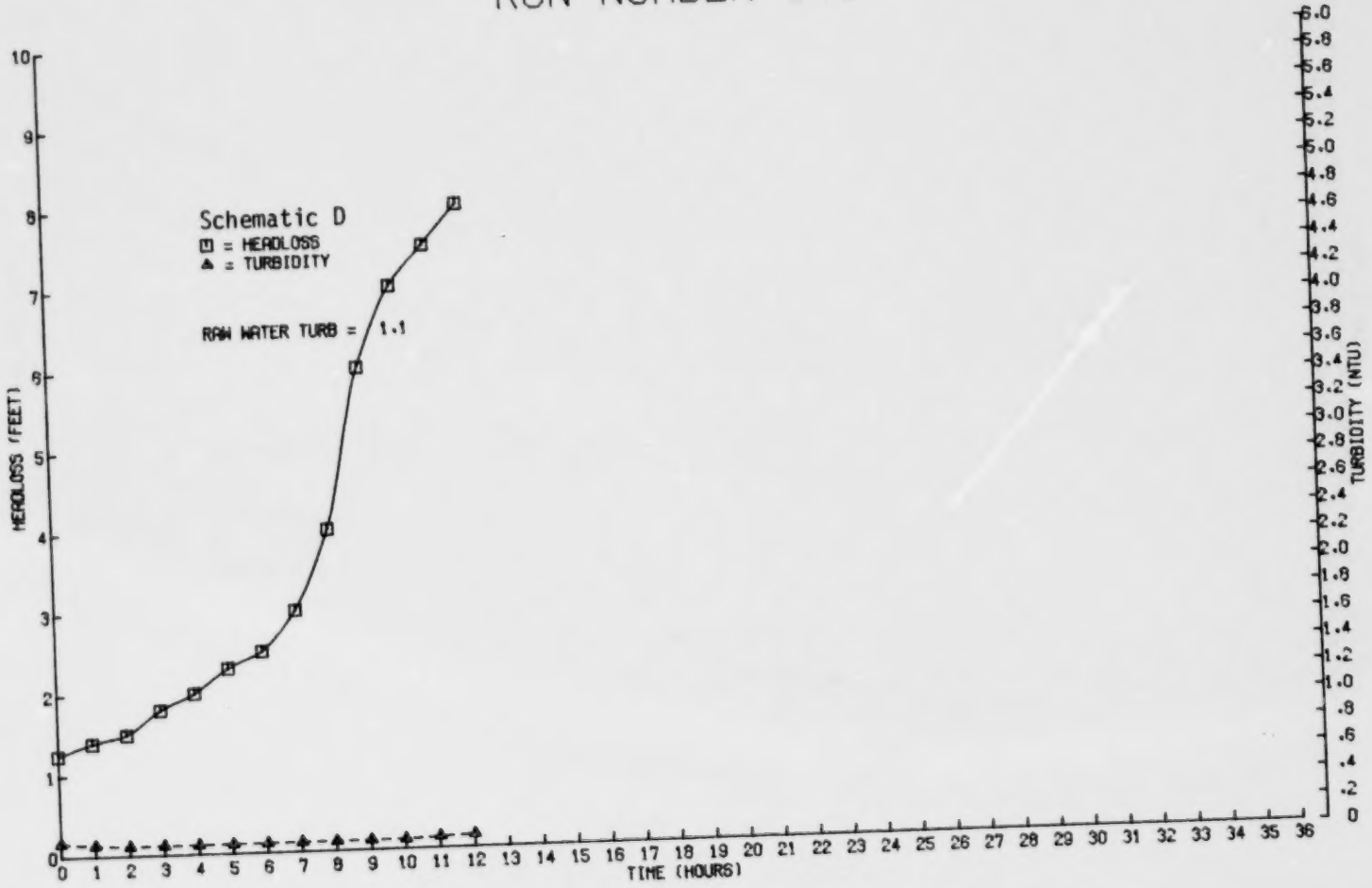
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 144F



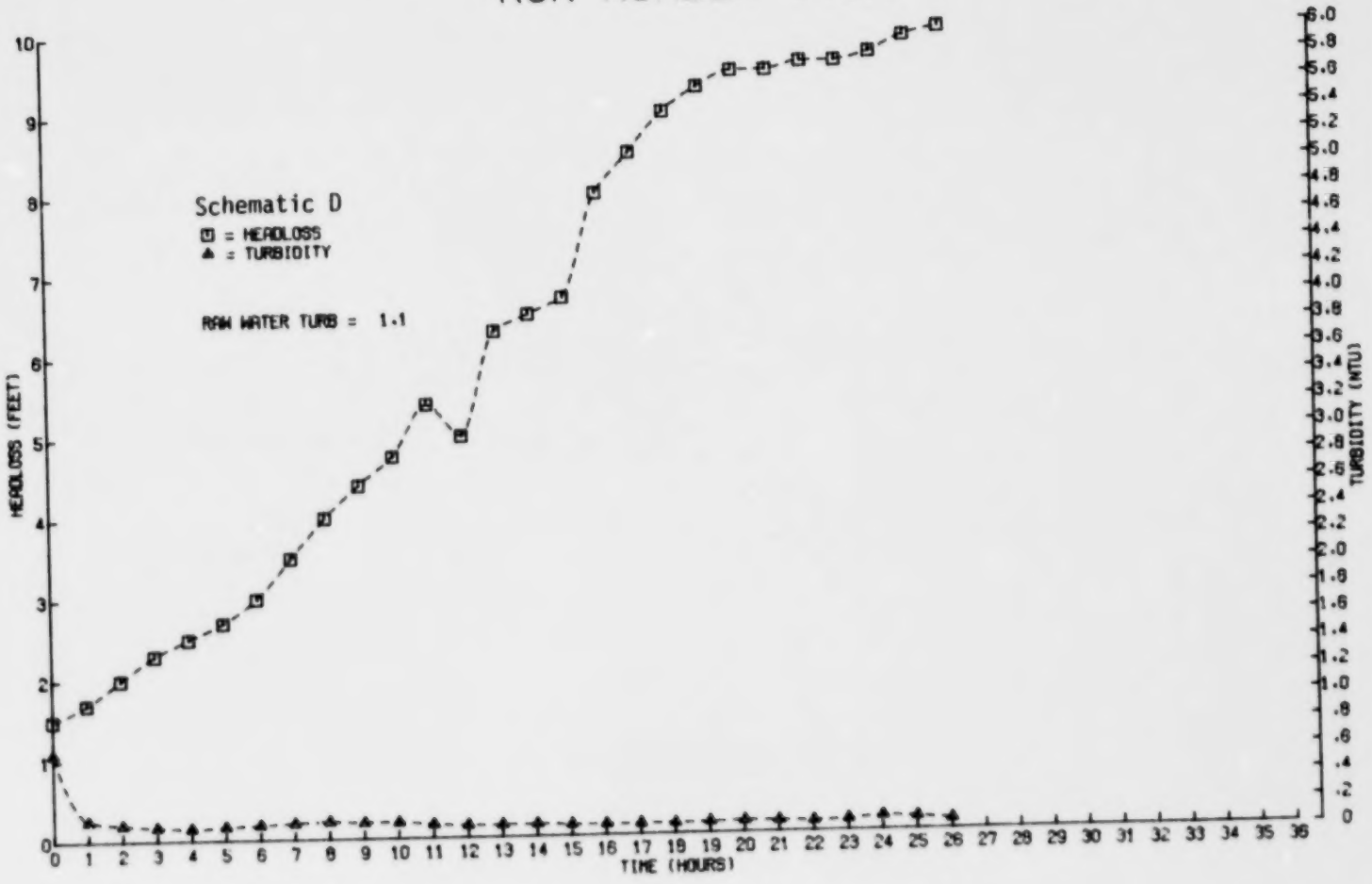
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 144C



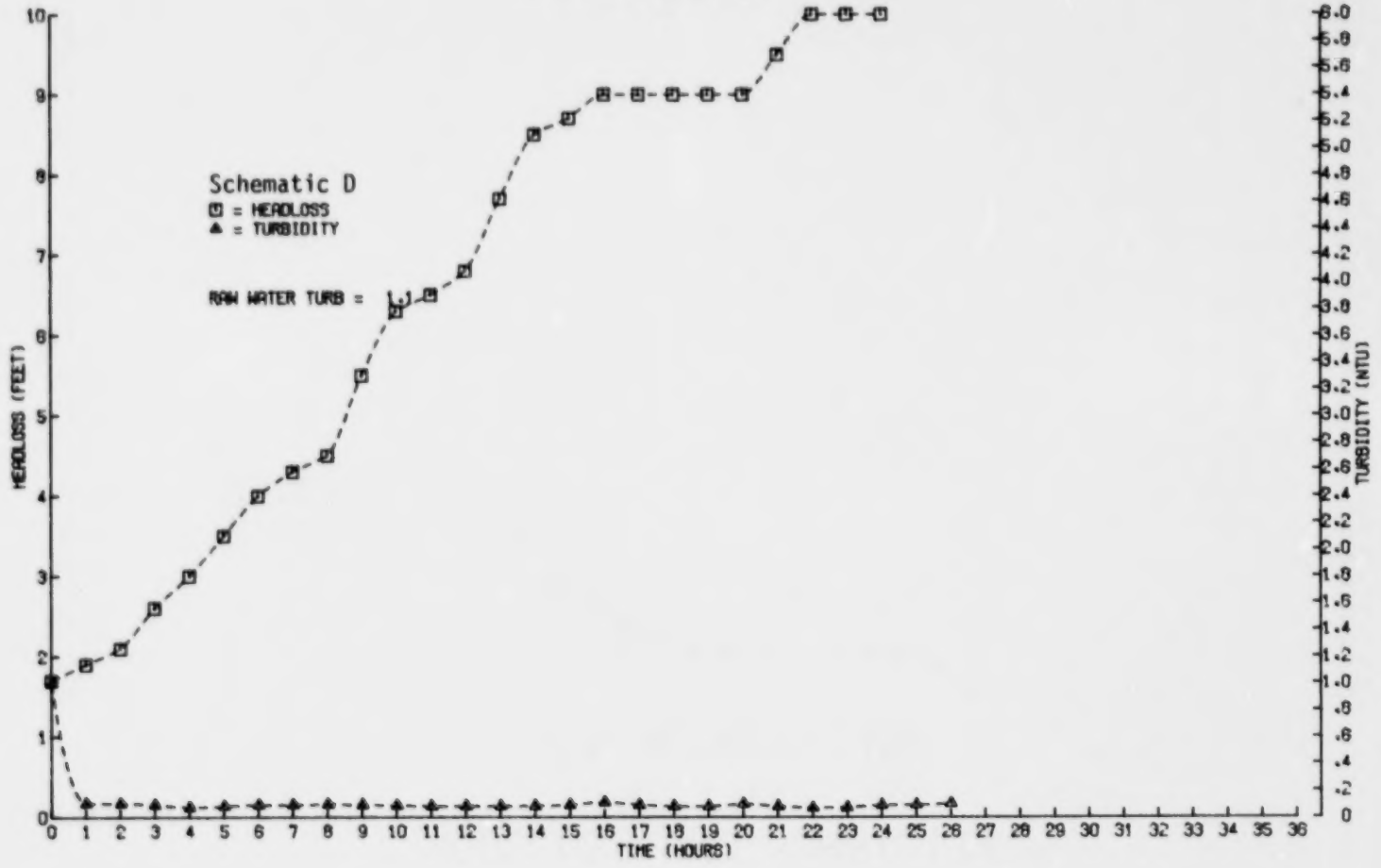
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 145



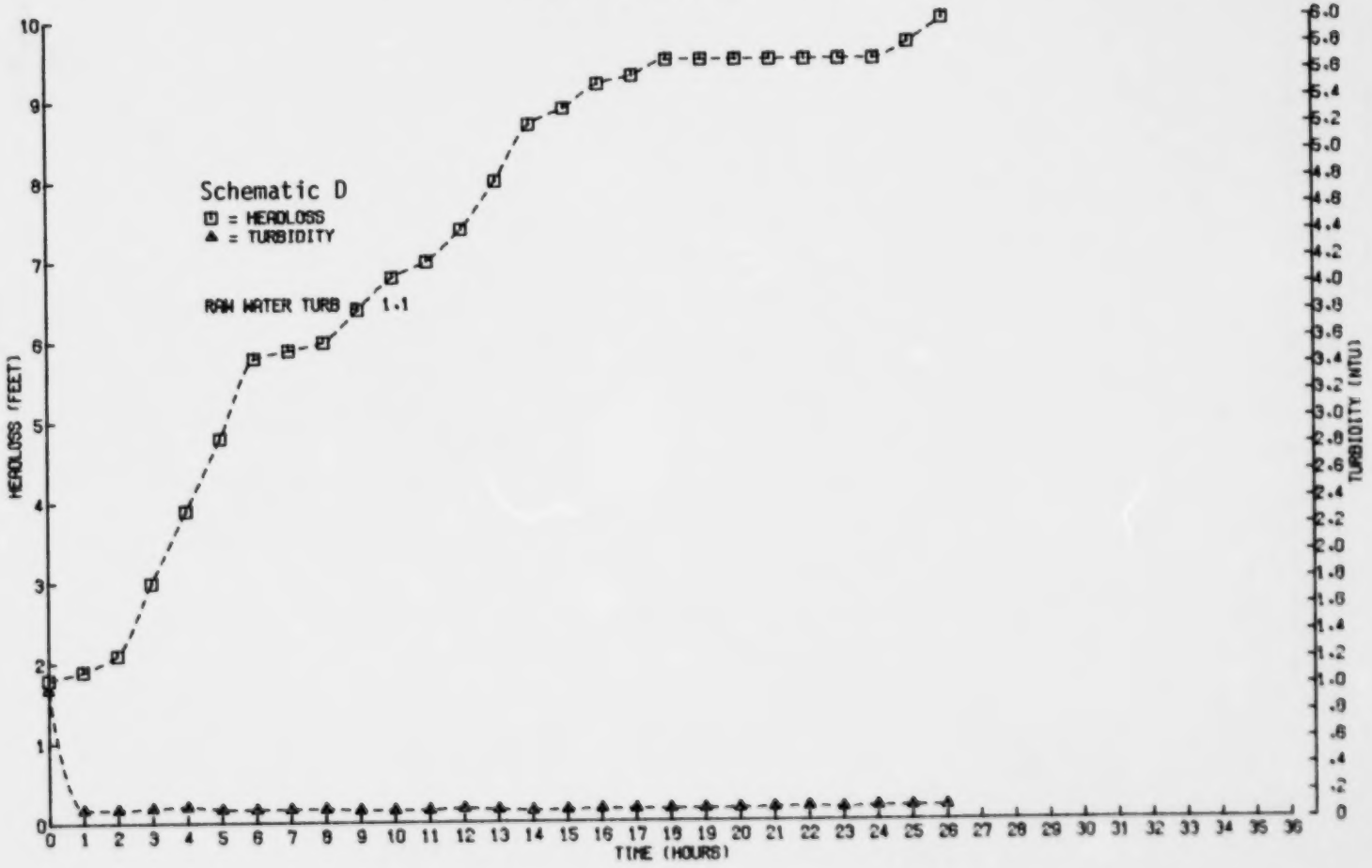
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 145M



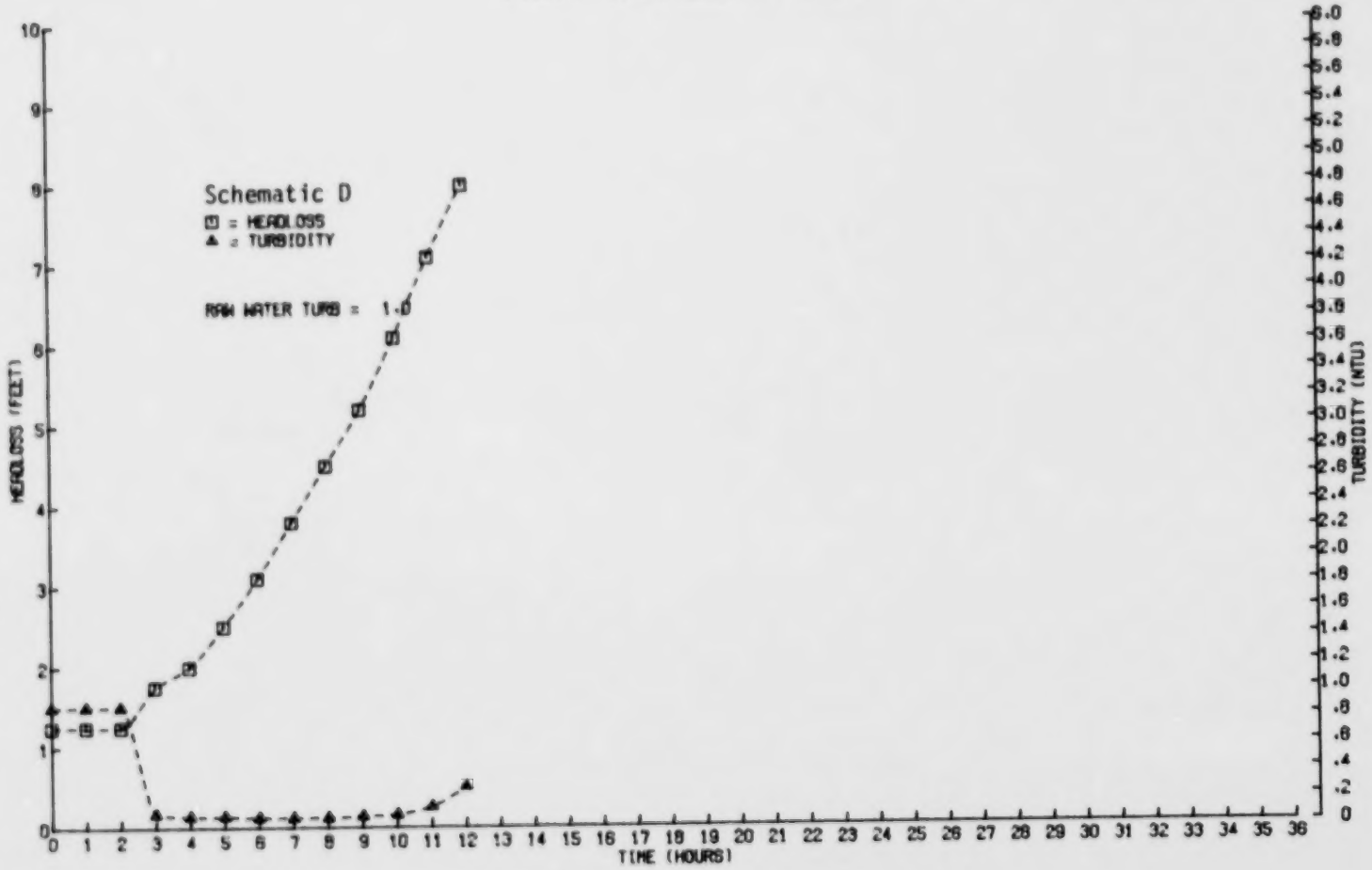
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 145C



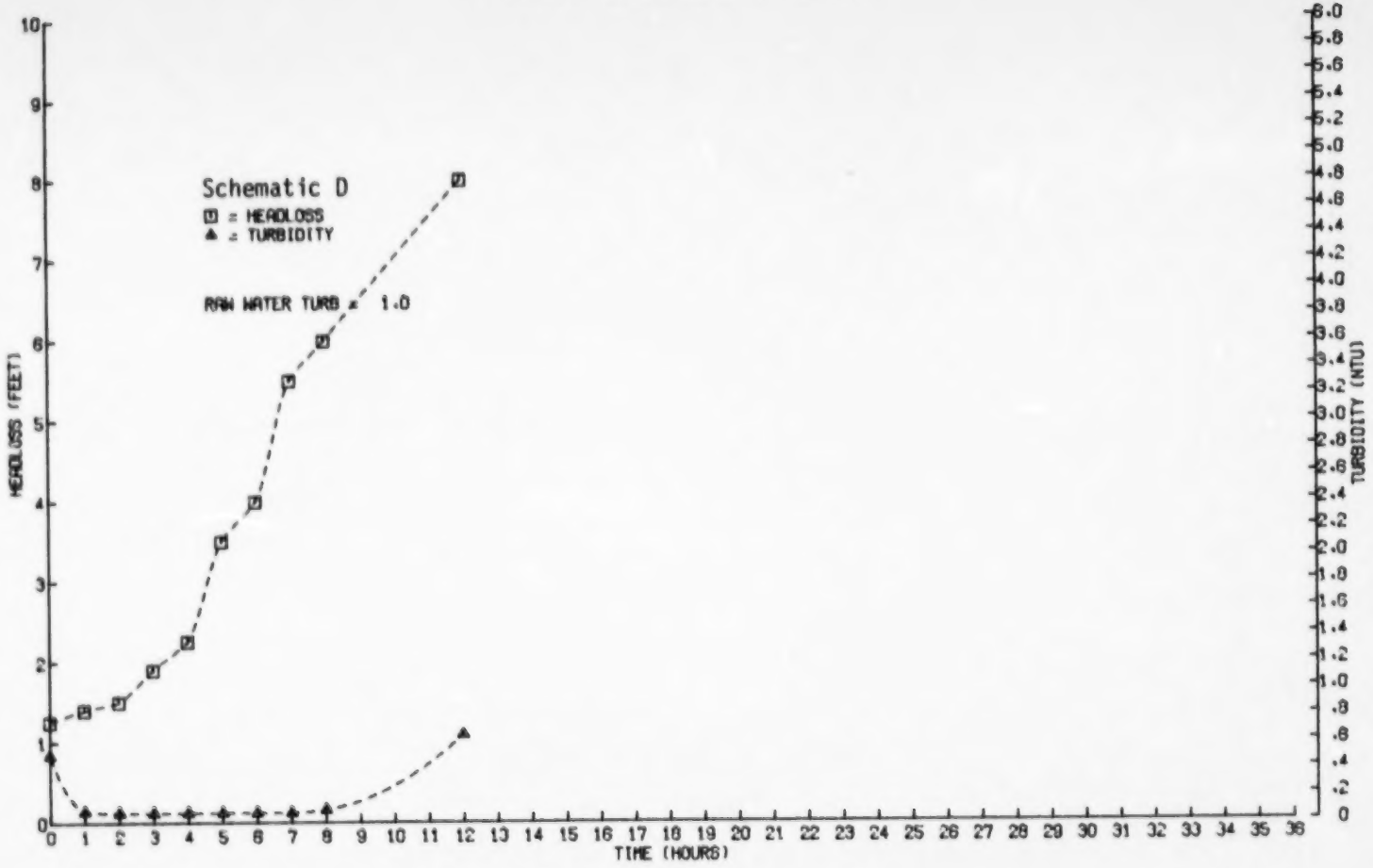
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 145F



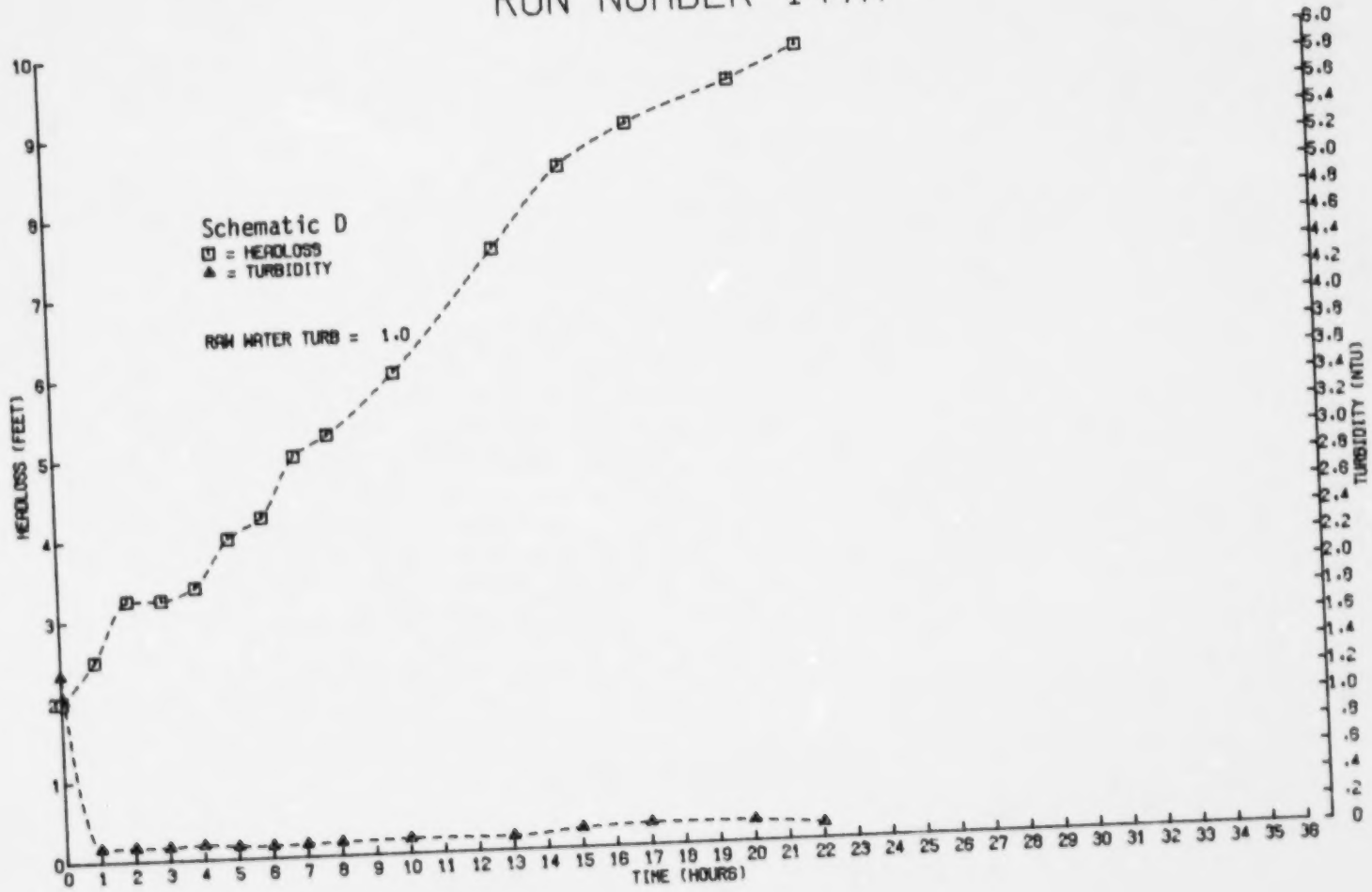
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 146



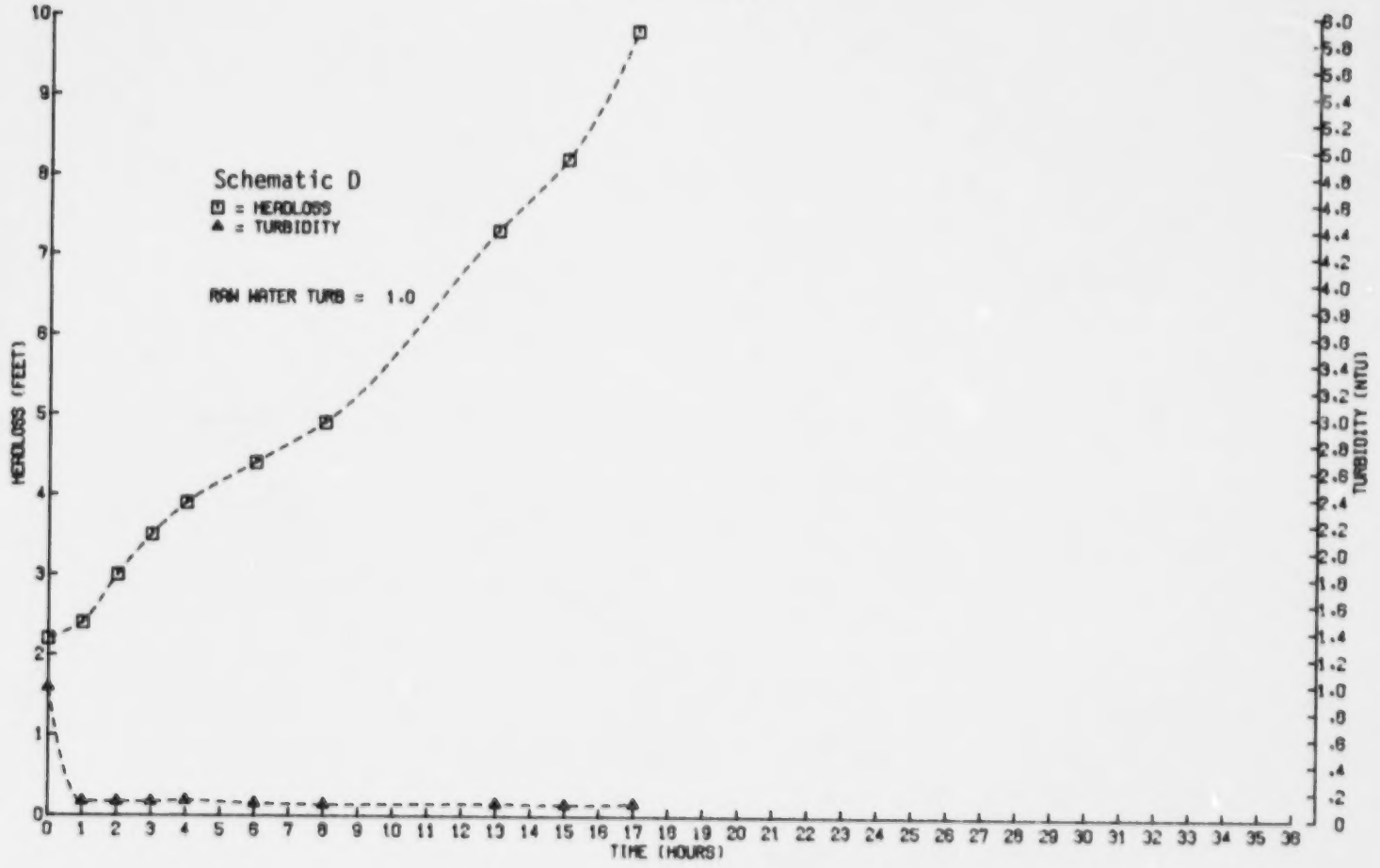
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 147



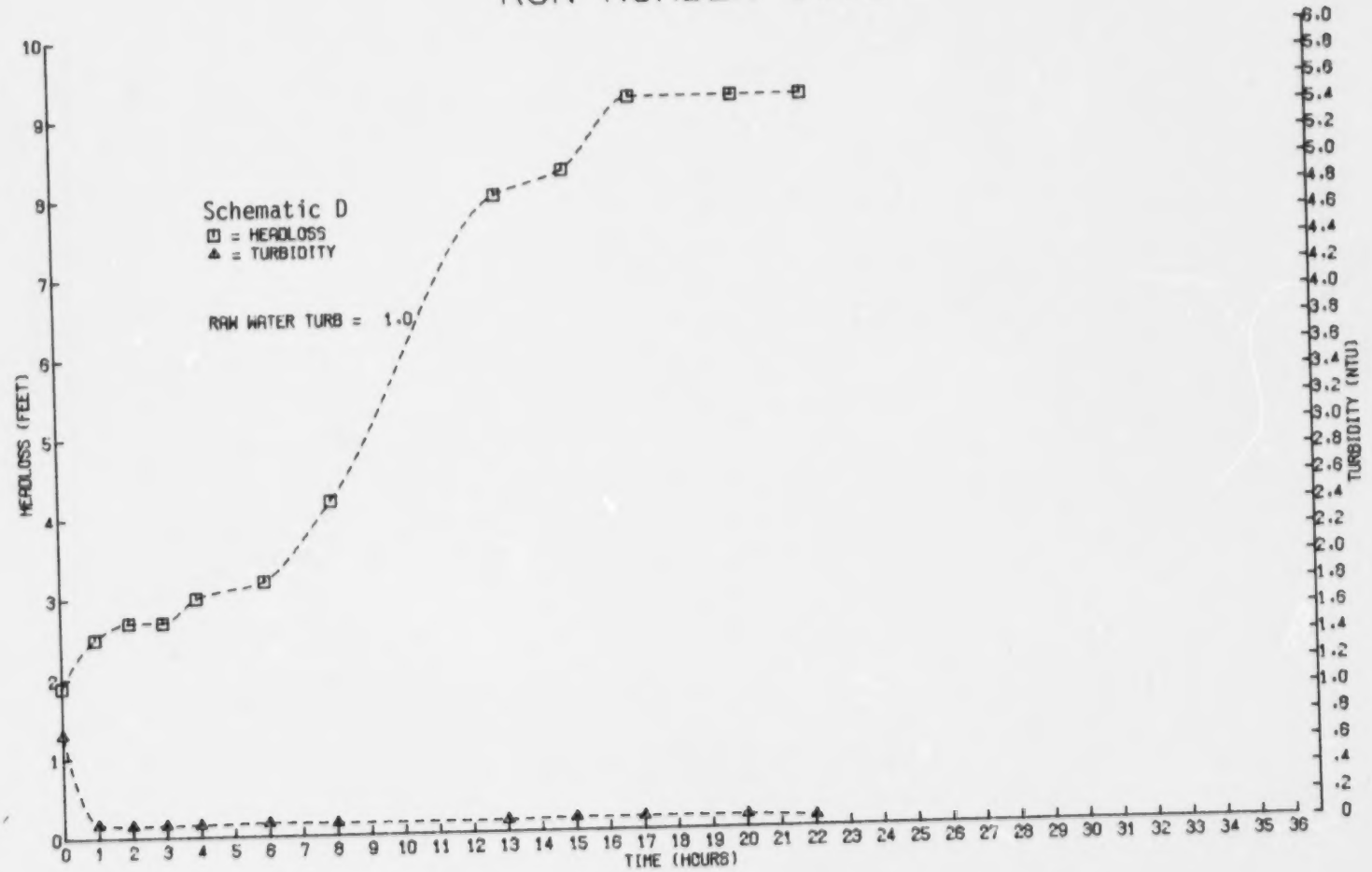
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 147M



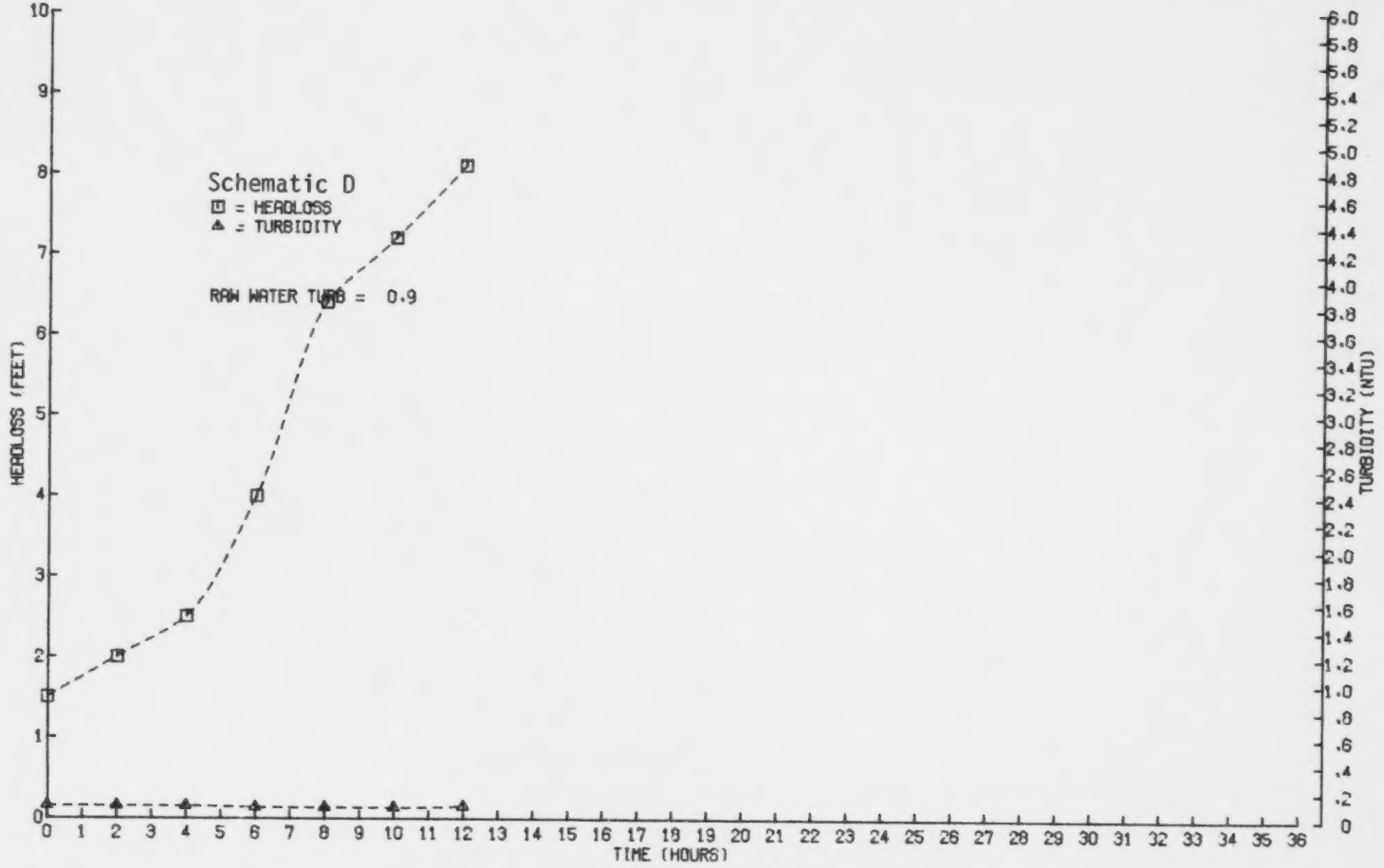
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 147F



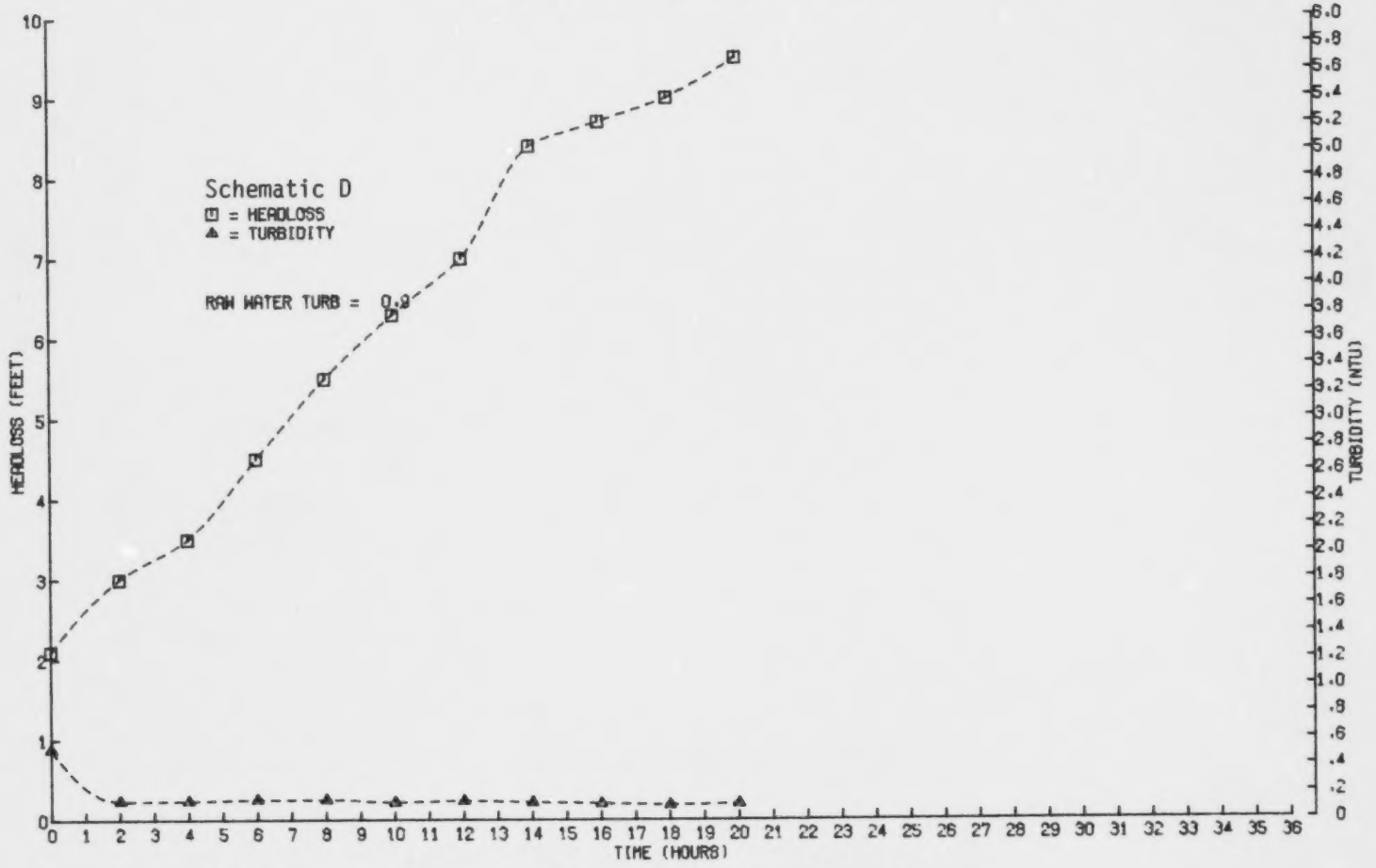
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 147C



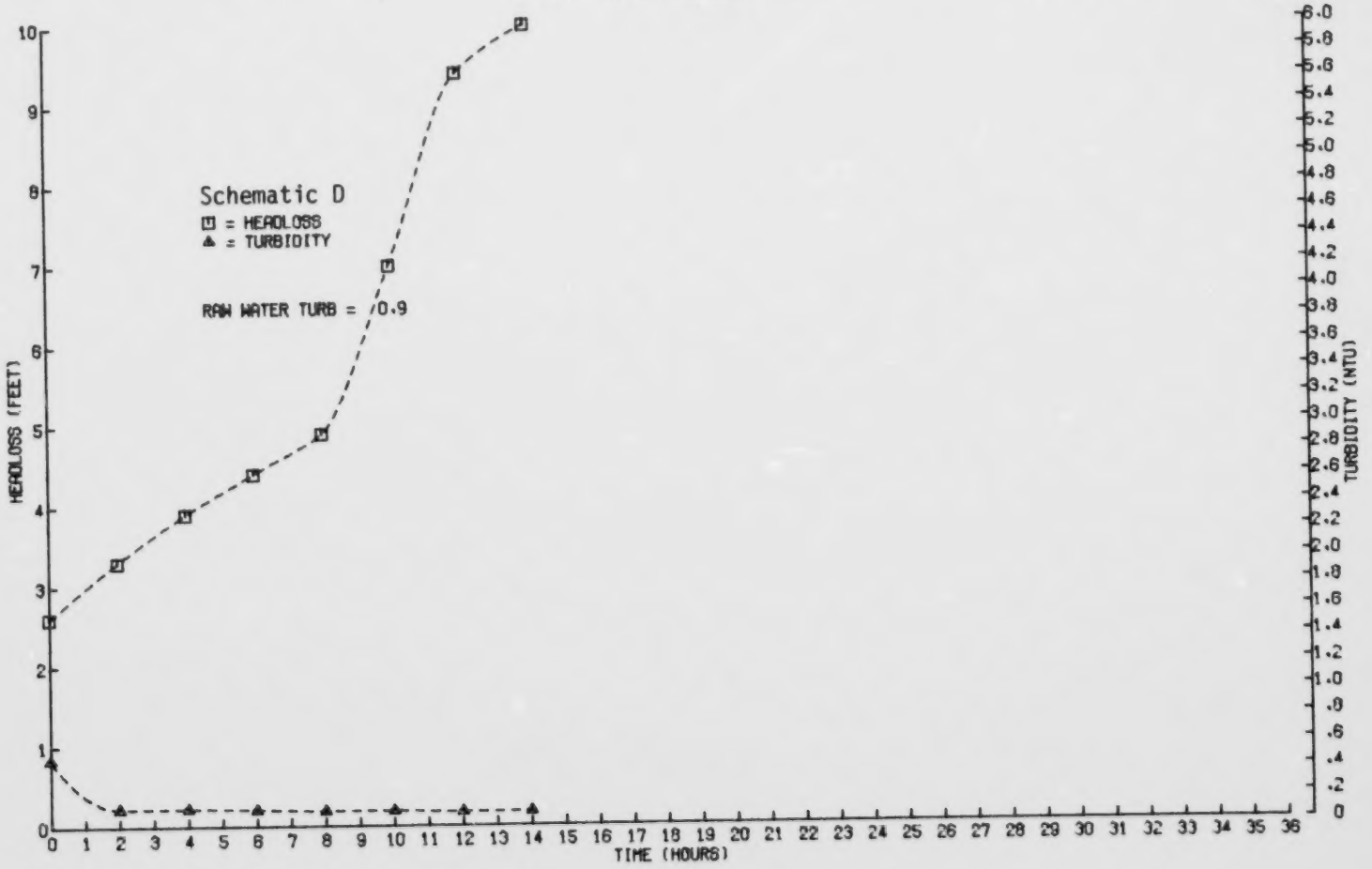
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 148



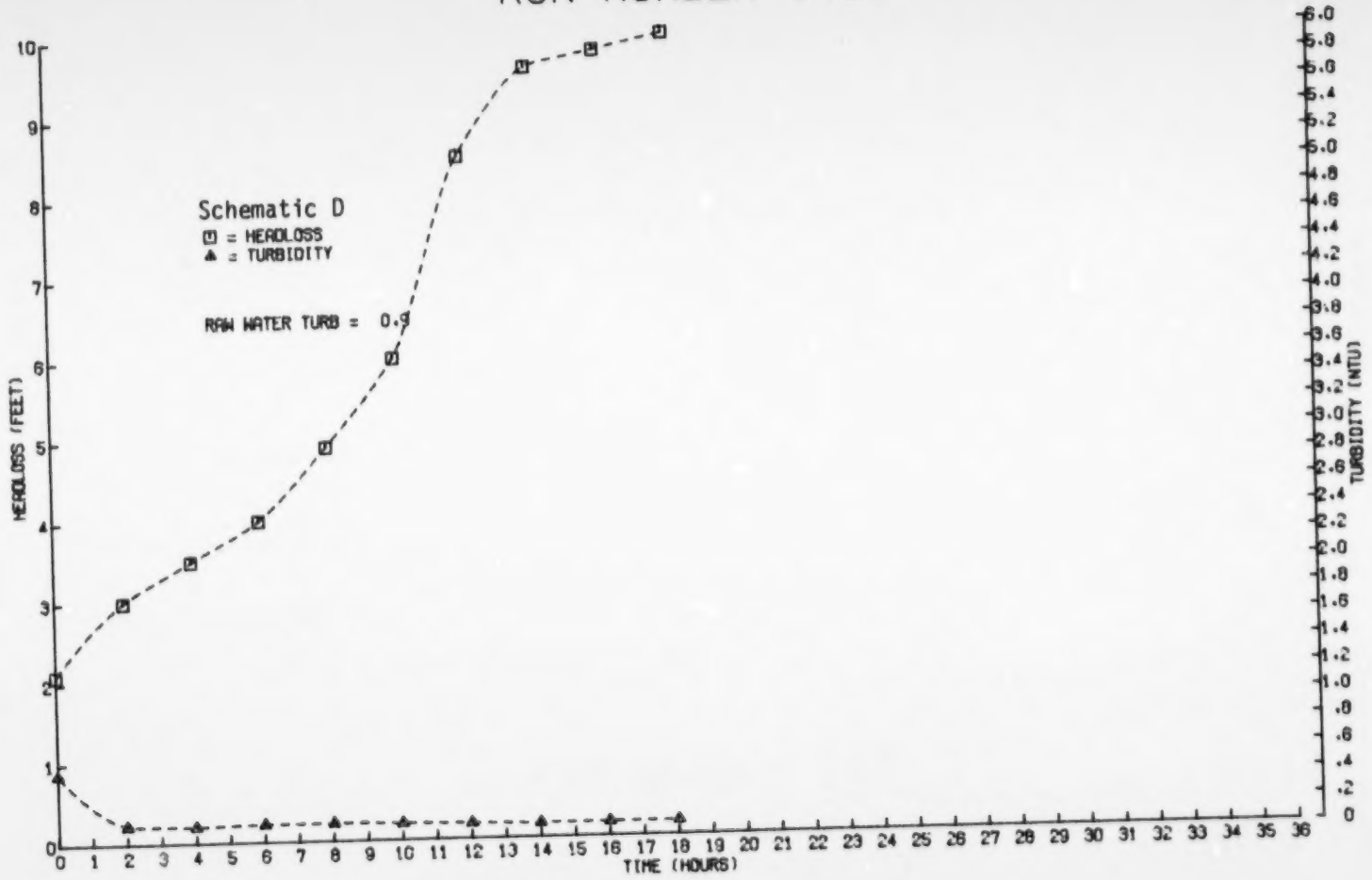
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 148M



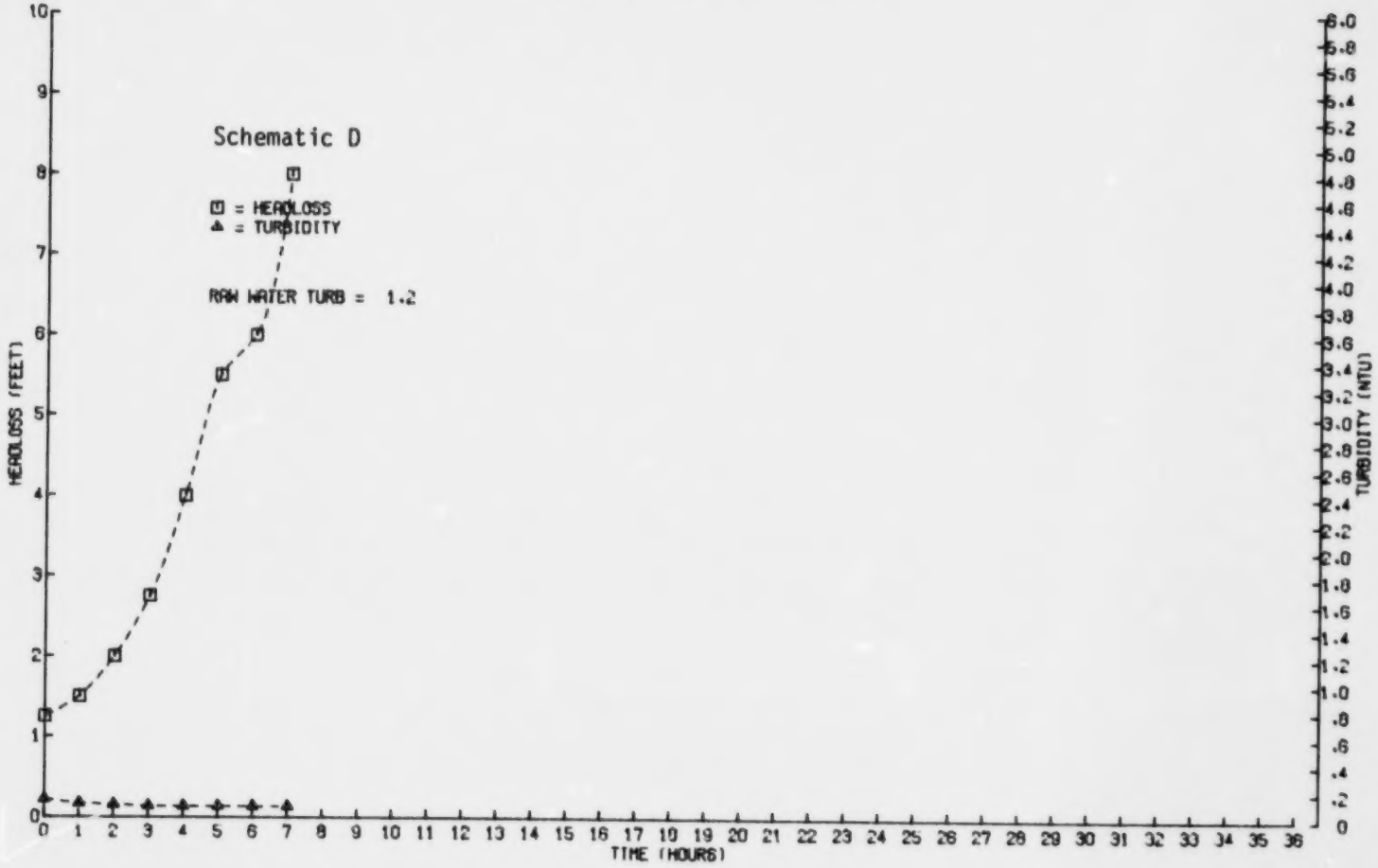
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 148F



HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 148C

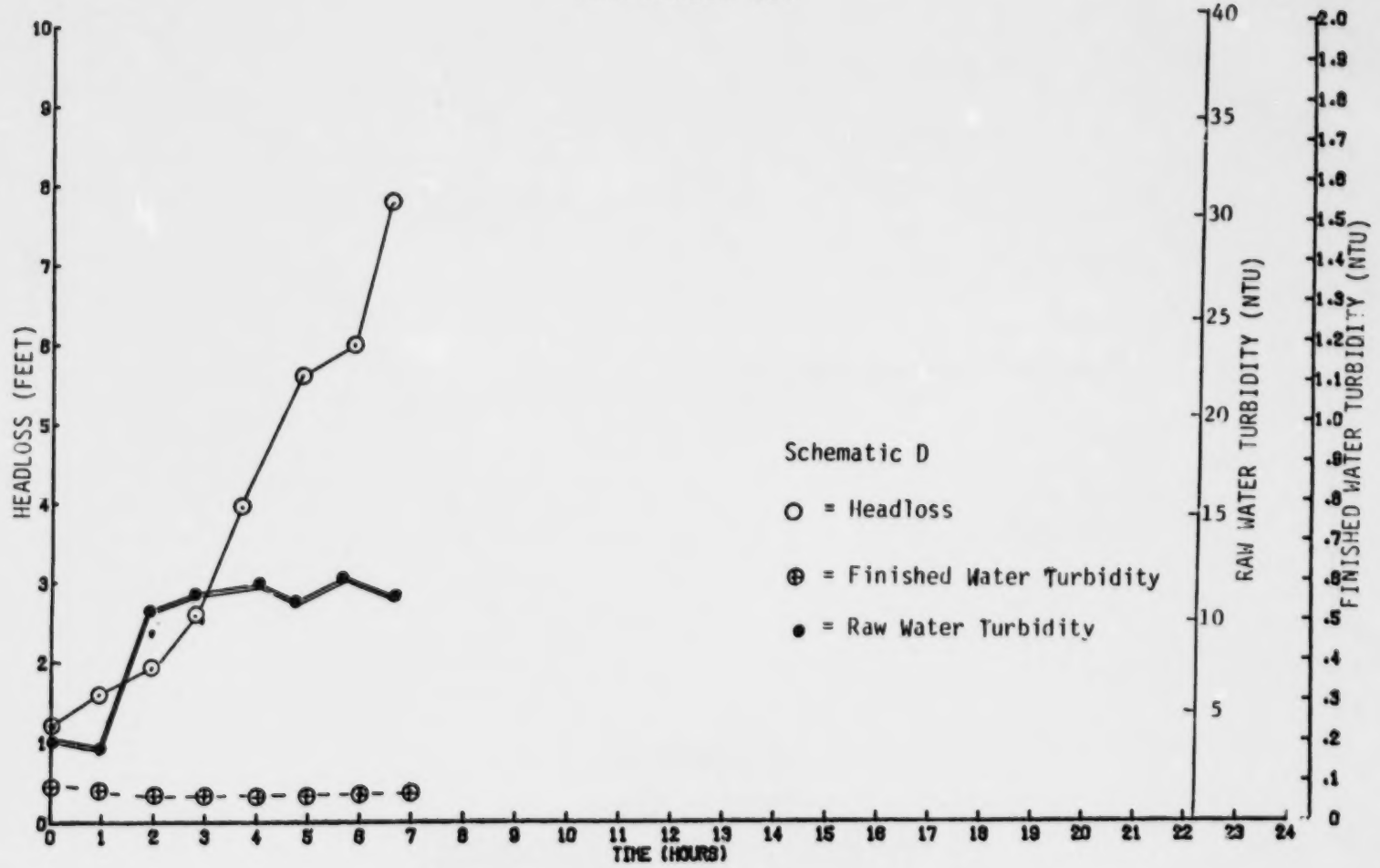


HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 149



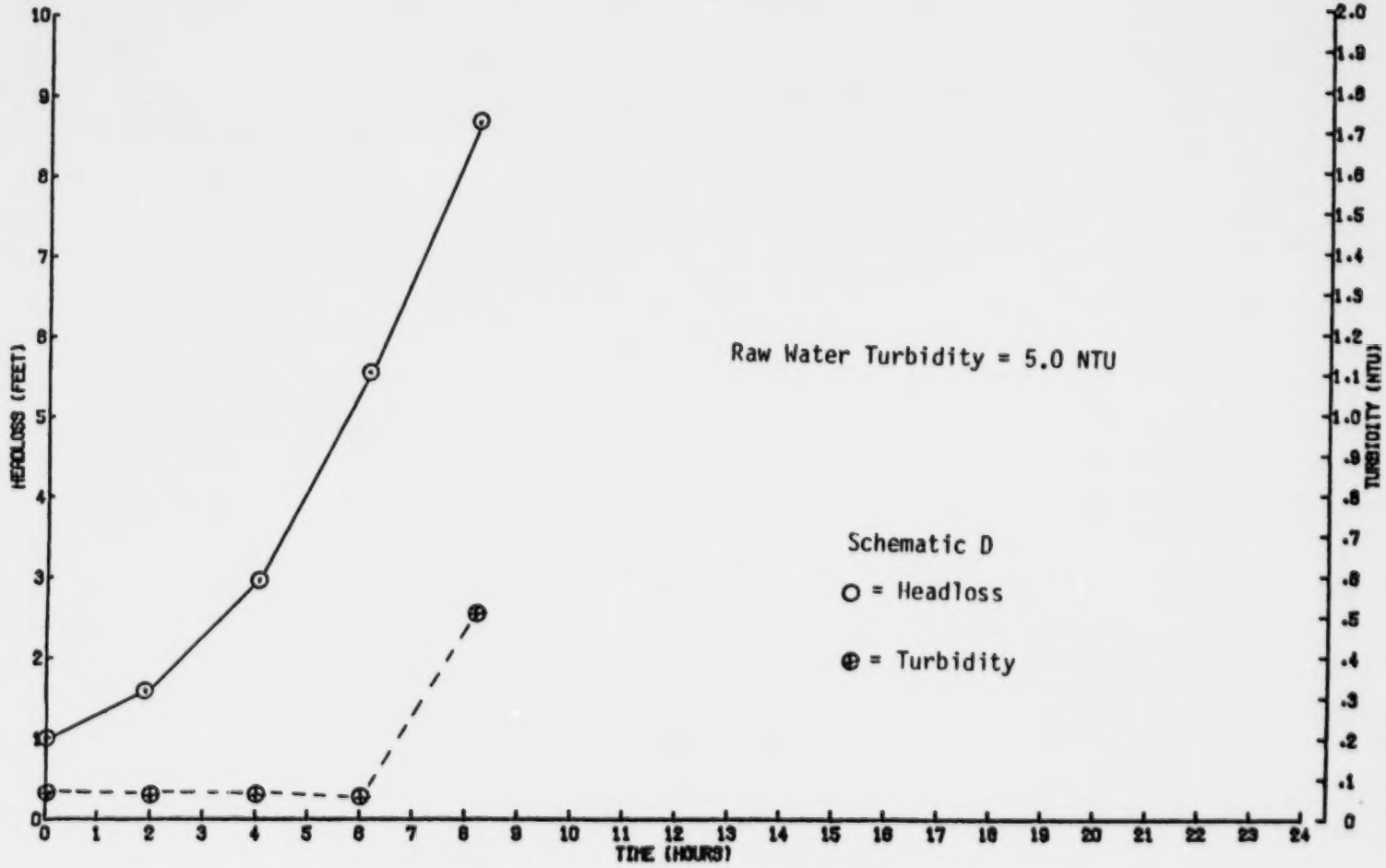
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 150



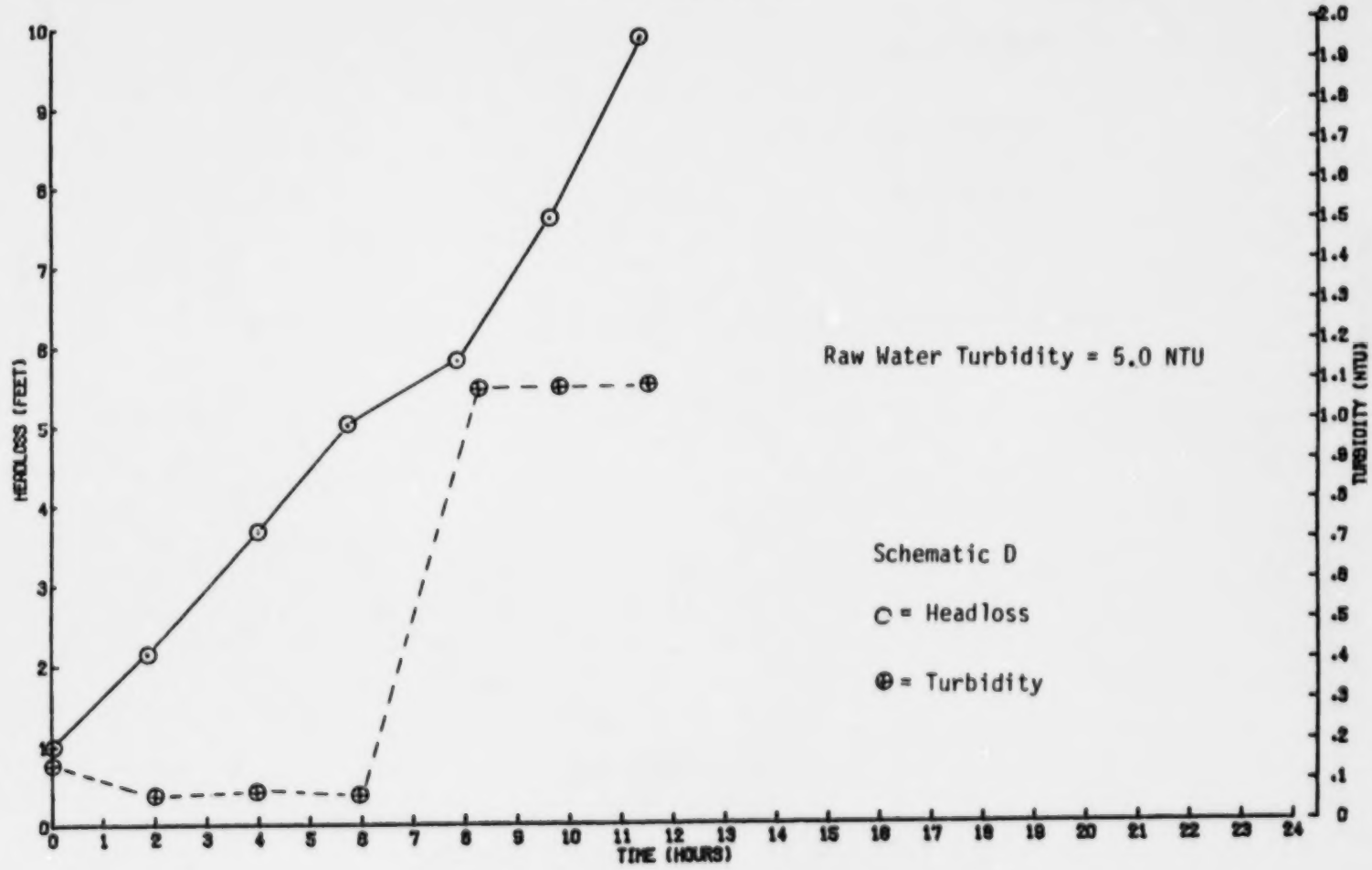
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 151



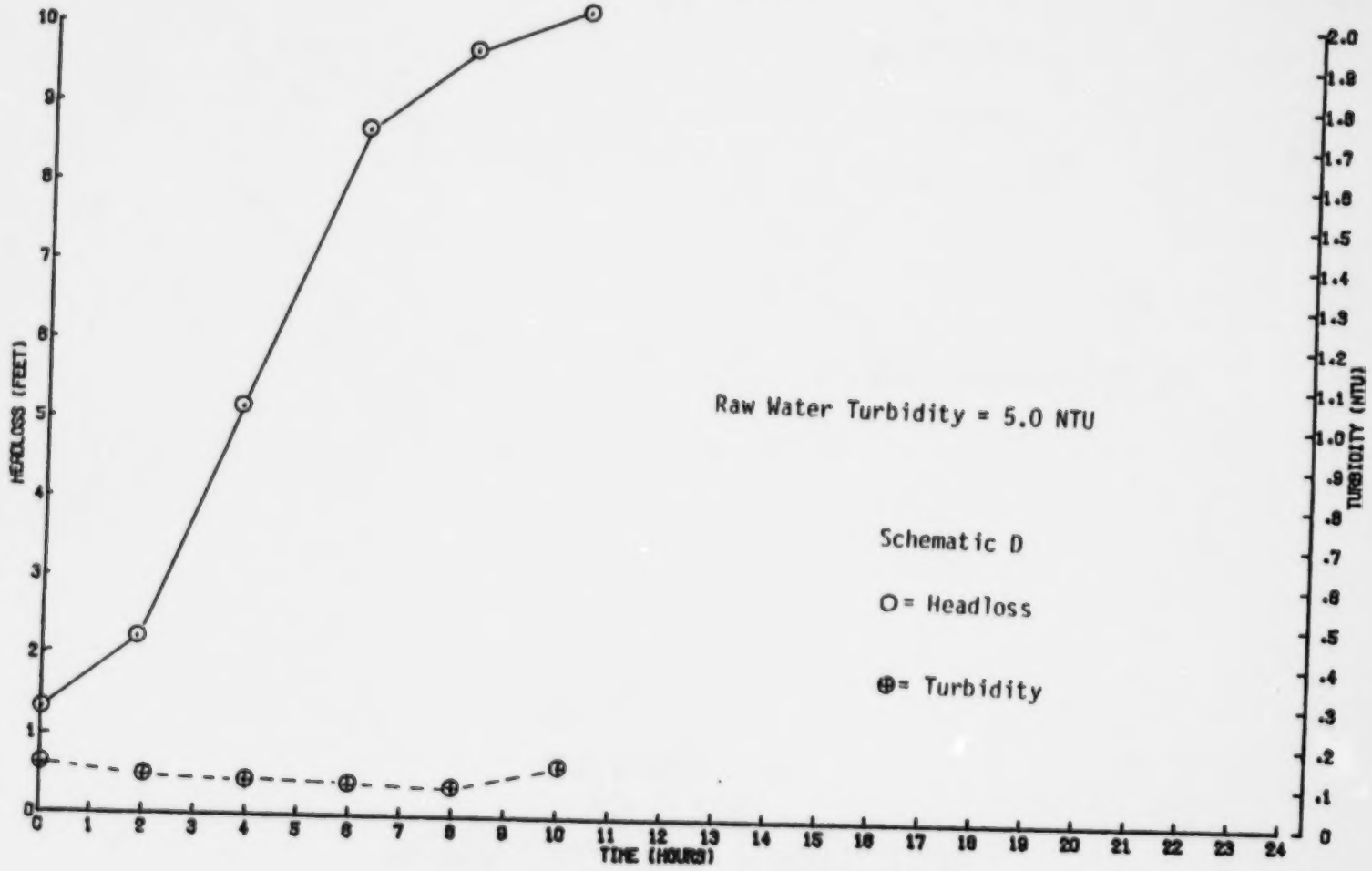
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 151MM



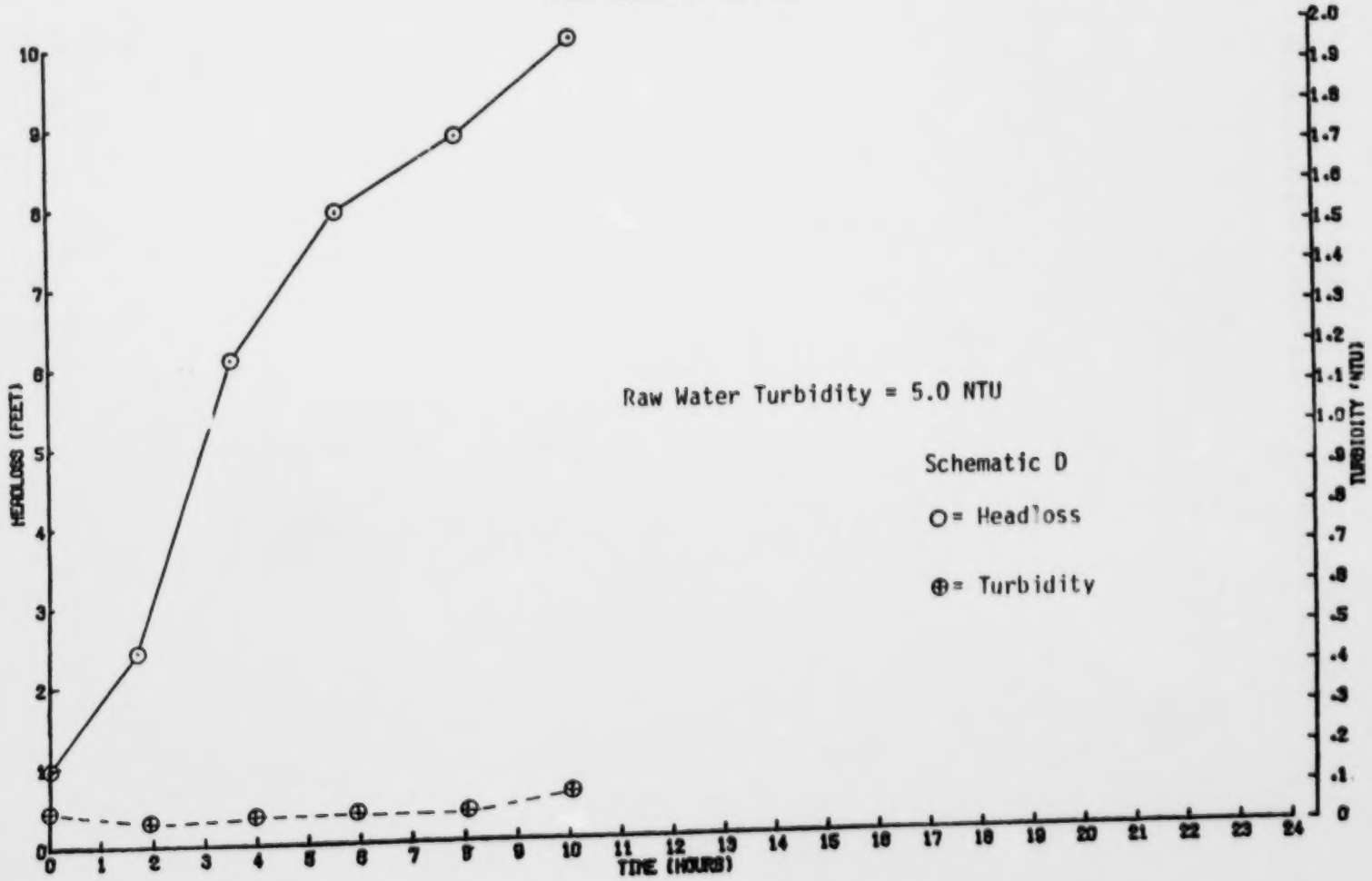
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 151FC

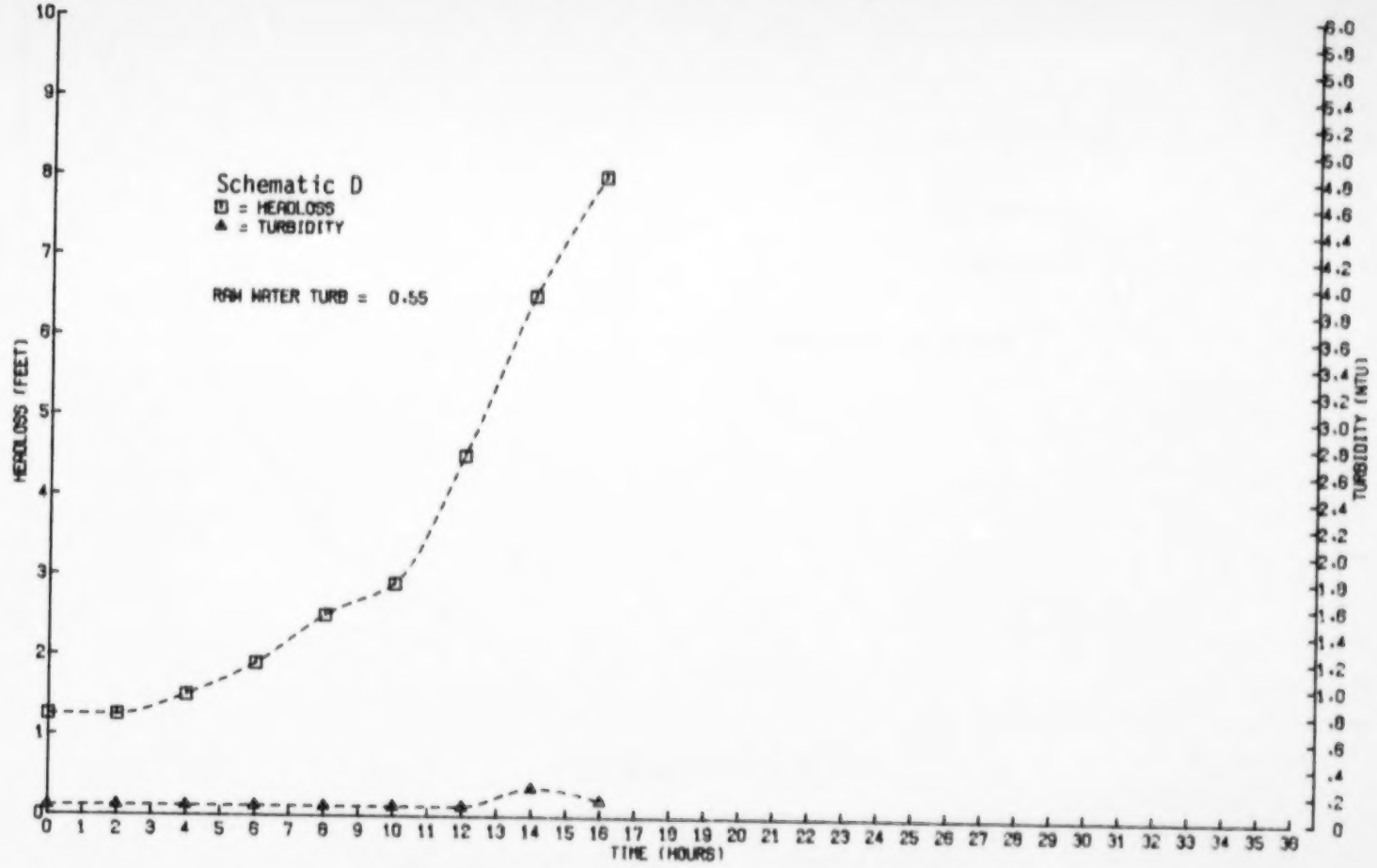


HEADLOSS AND TURBIDITY VS TIME

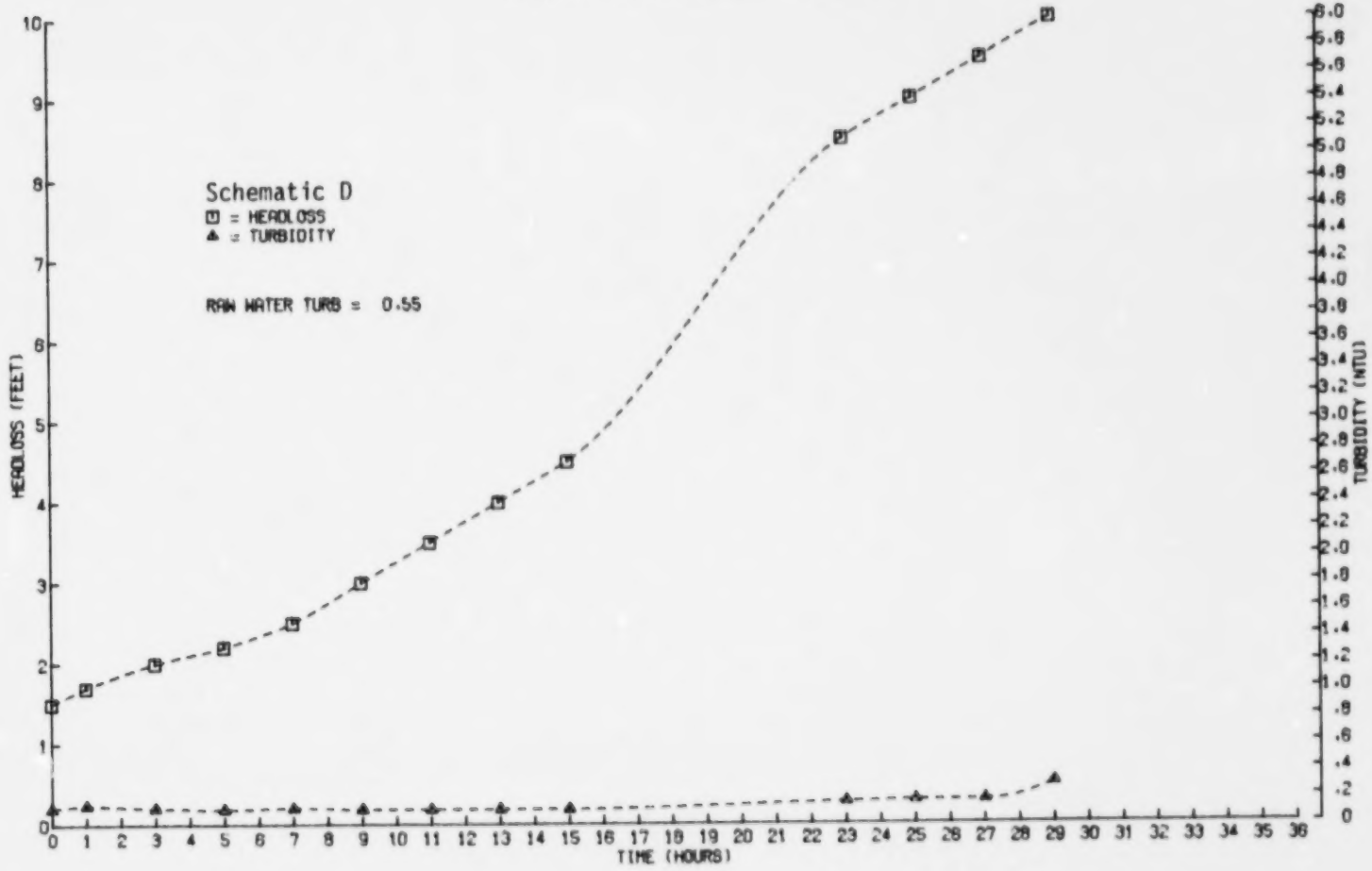
RUN NUMBER 151CC



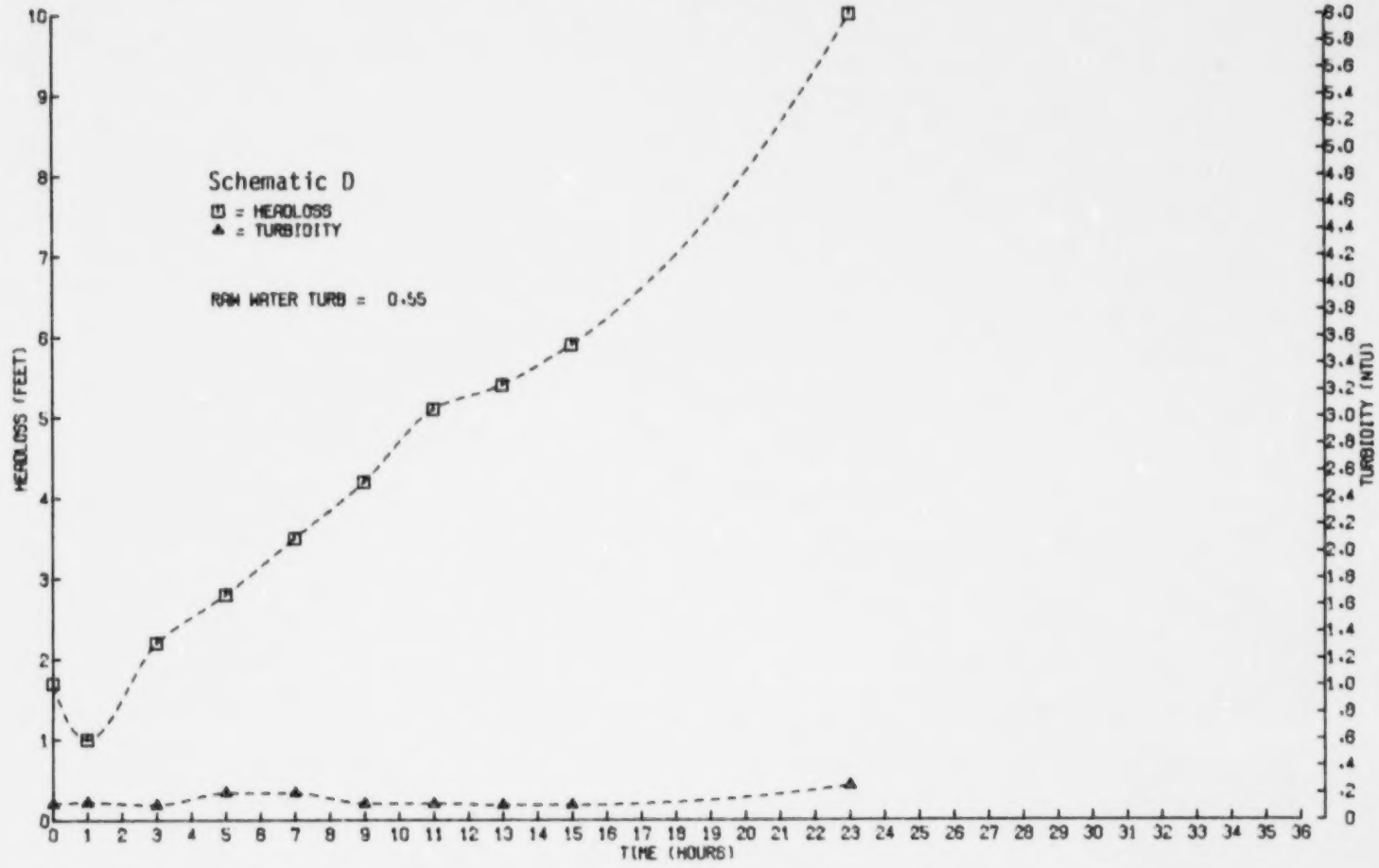
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 152



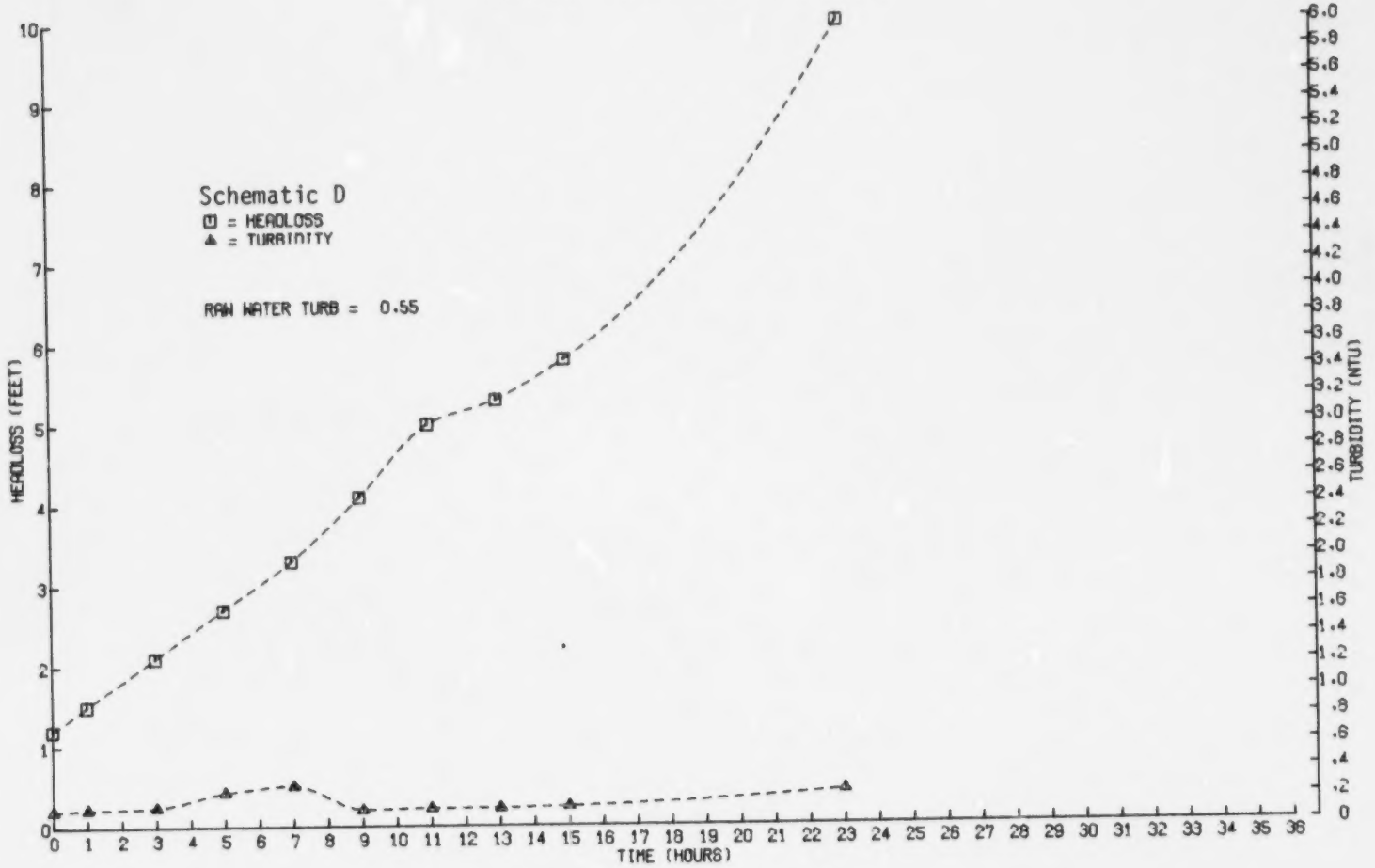
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 152M



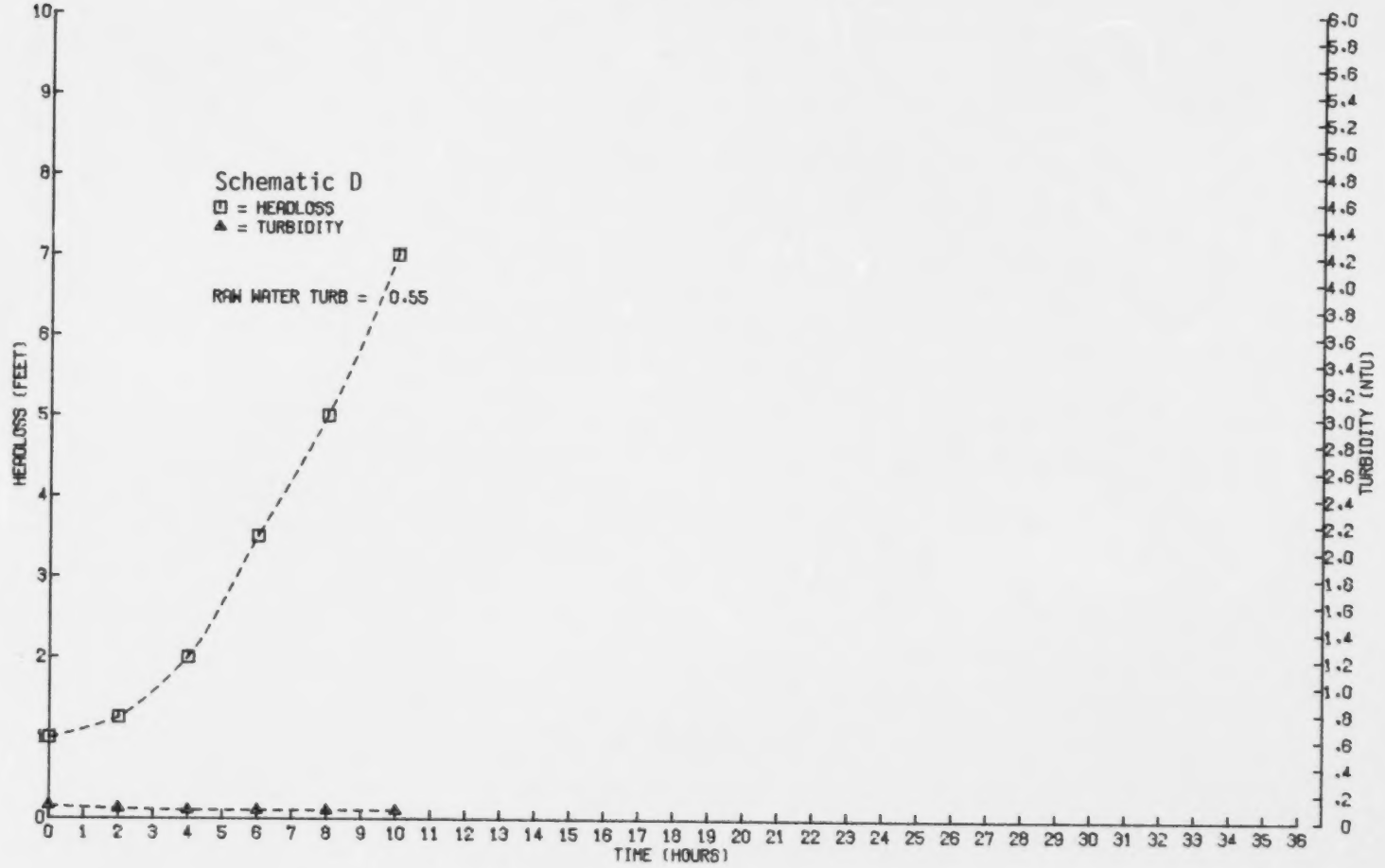
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 152F



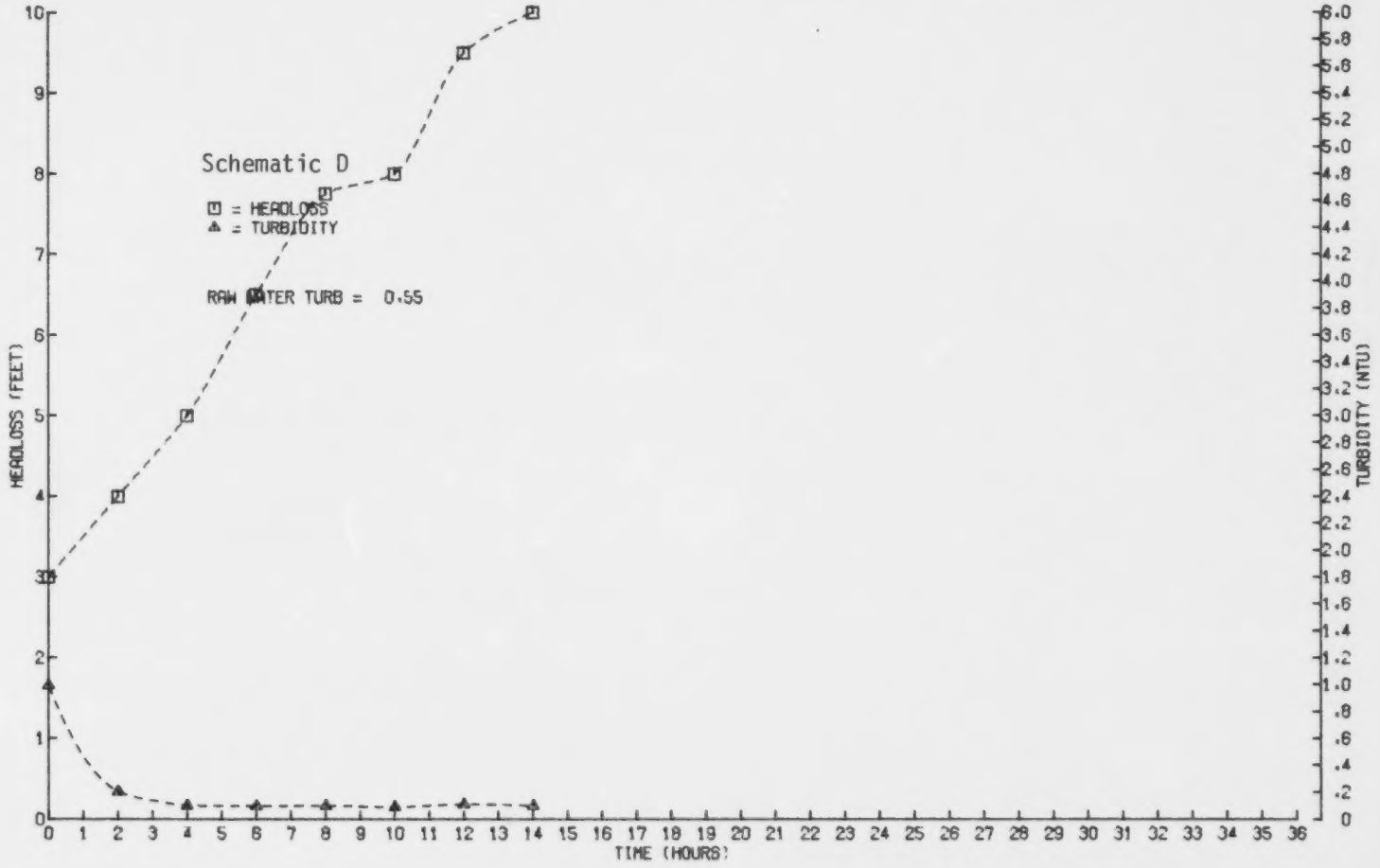
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 152C



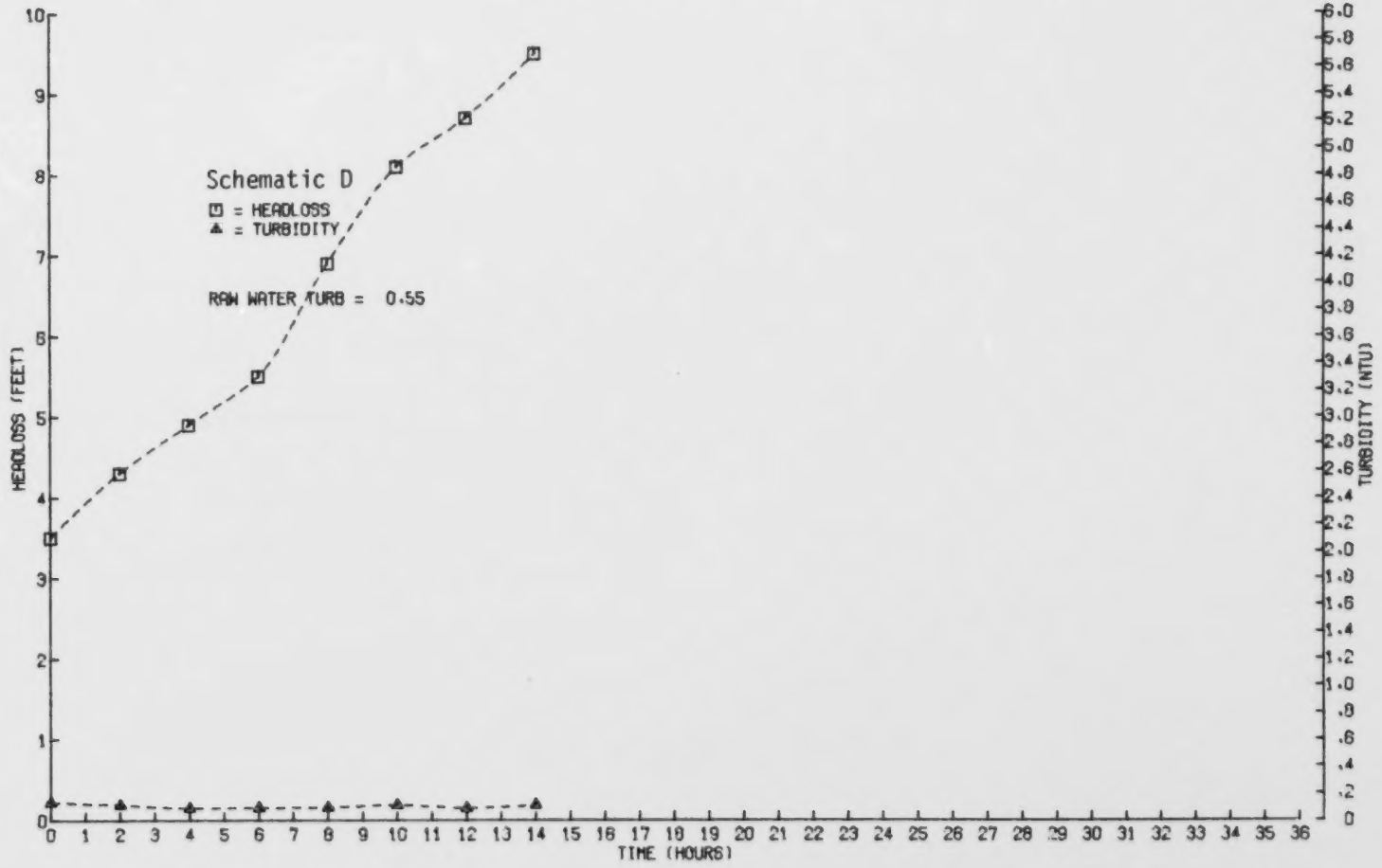
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 153



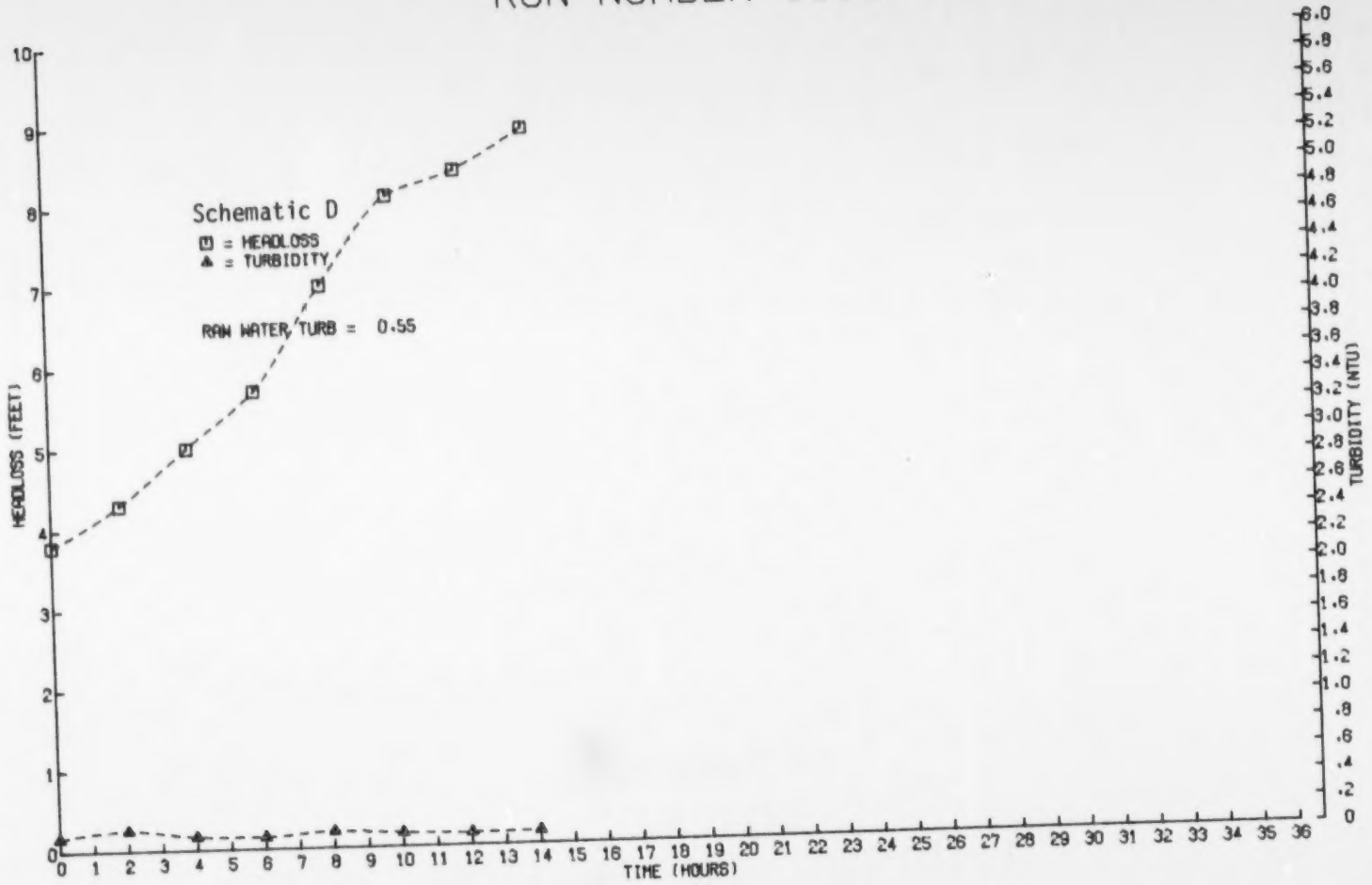
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 153M



HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 153F

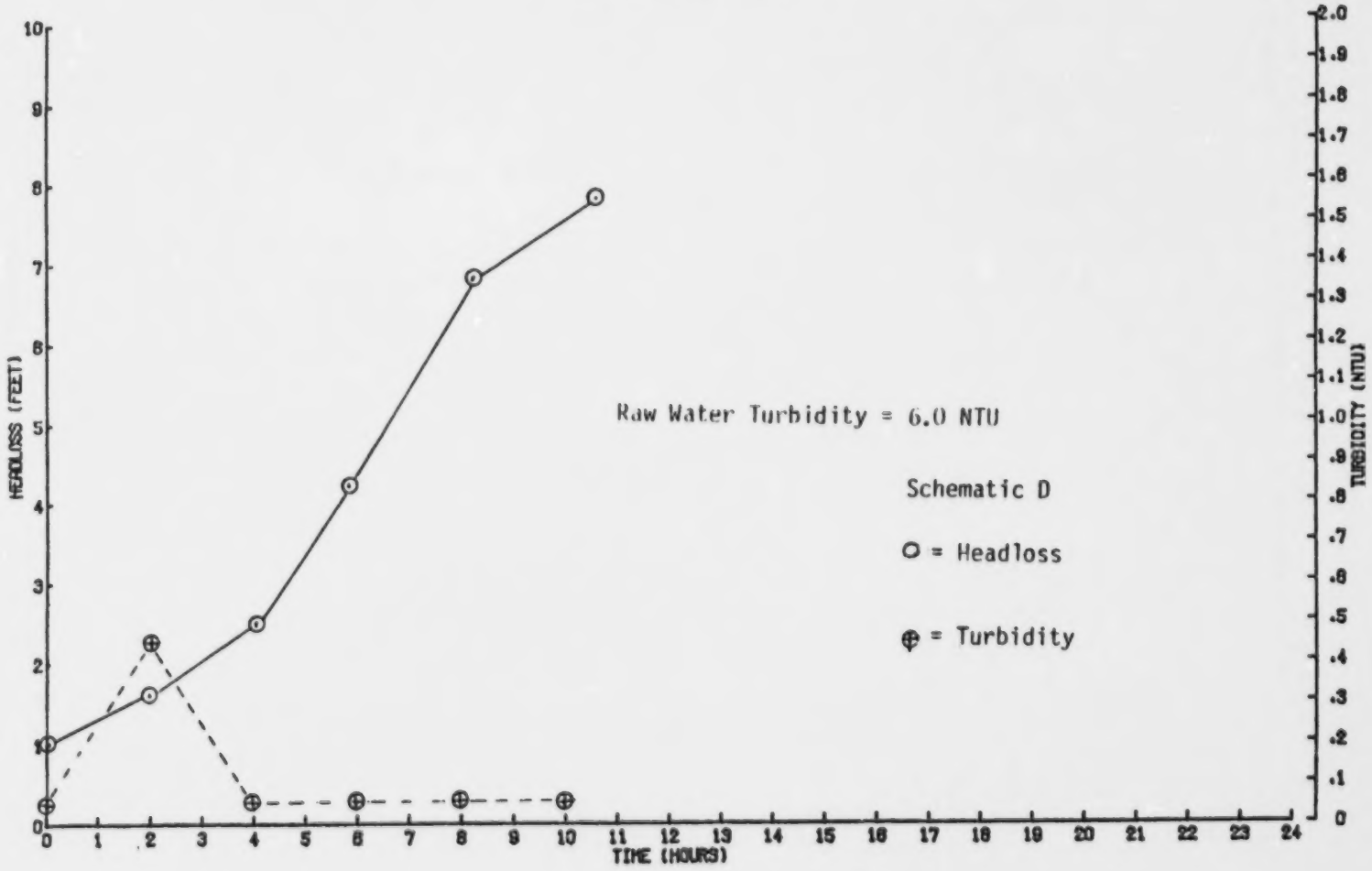


HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 153C



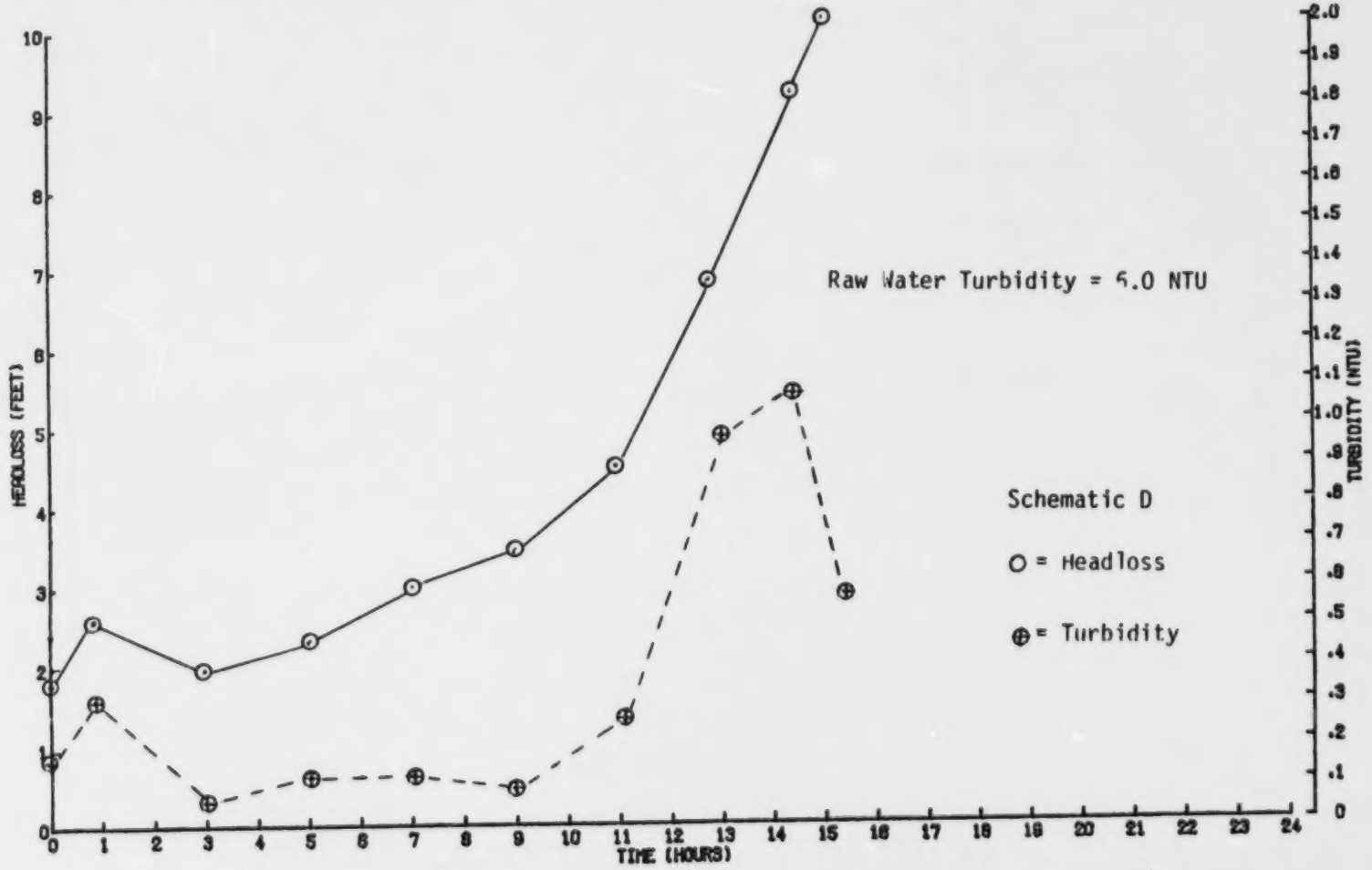
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 154



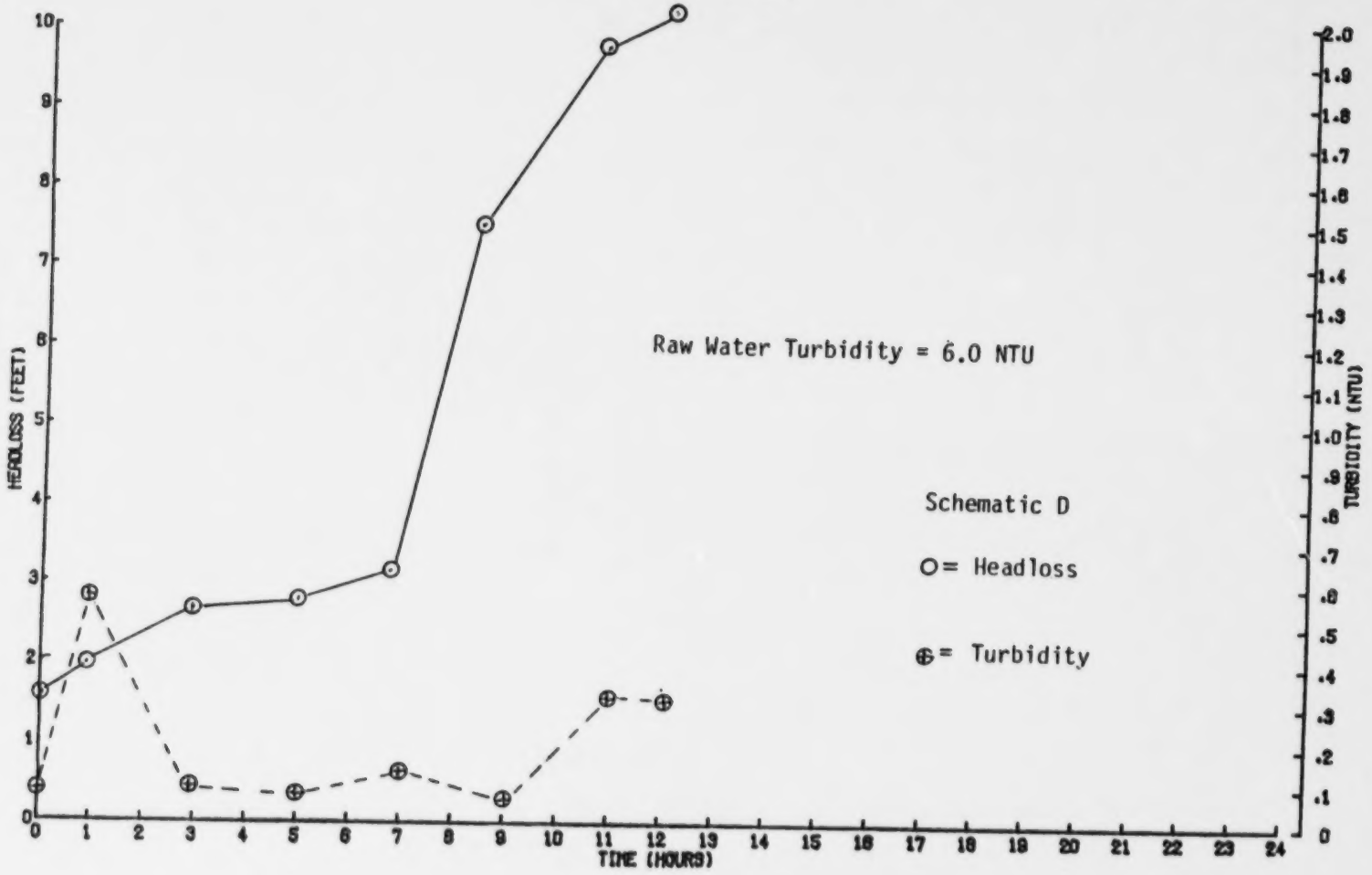
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 154MM



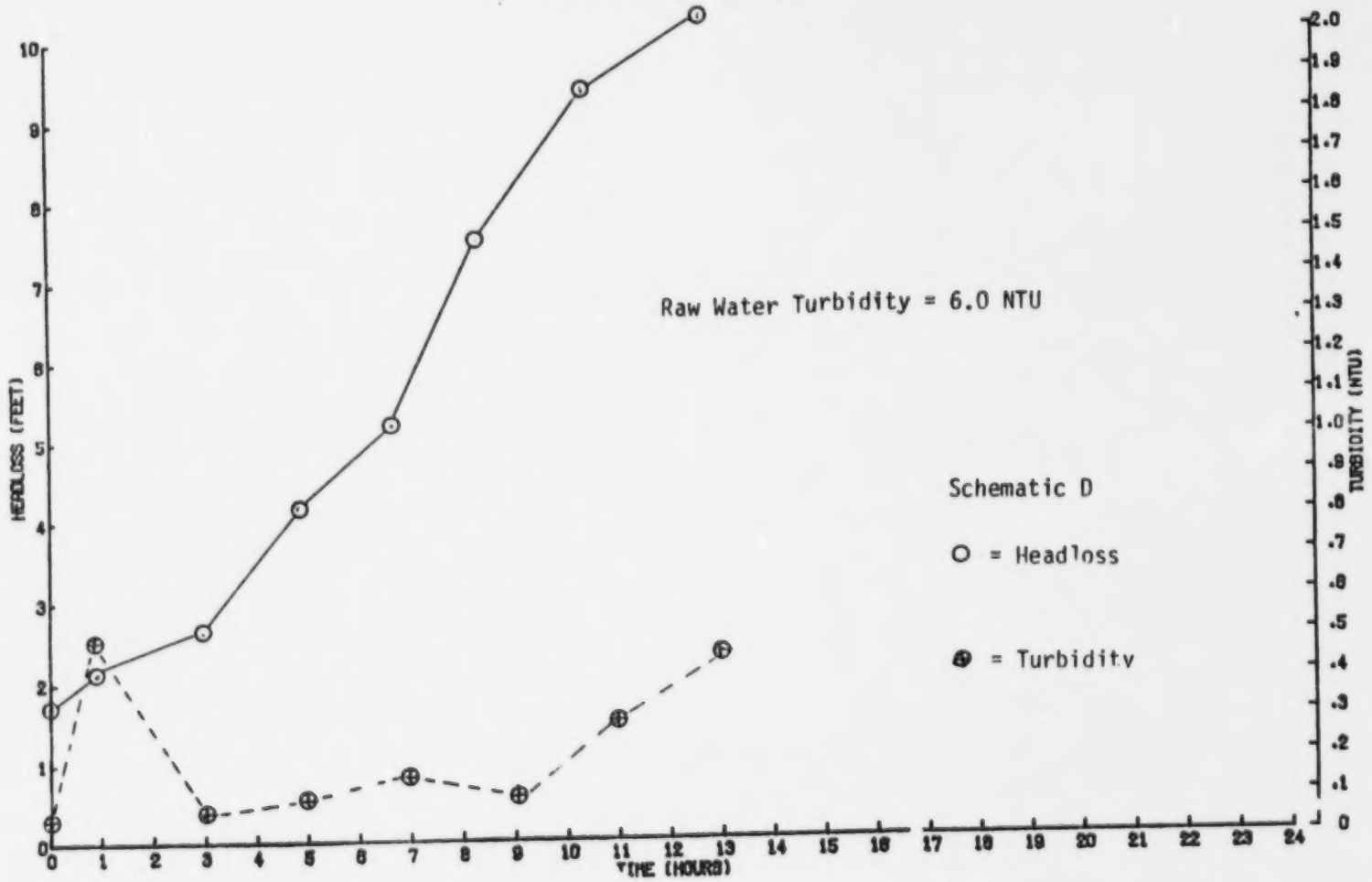
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 154FC

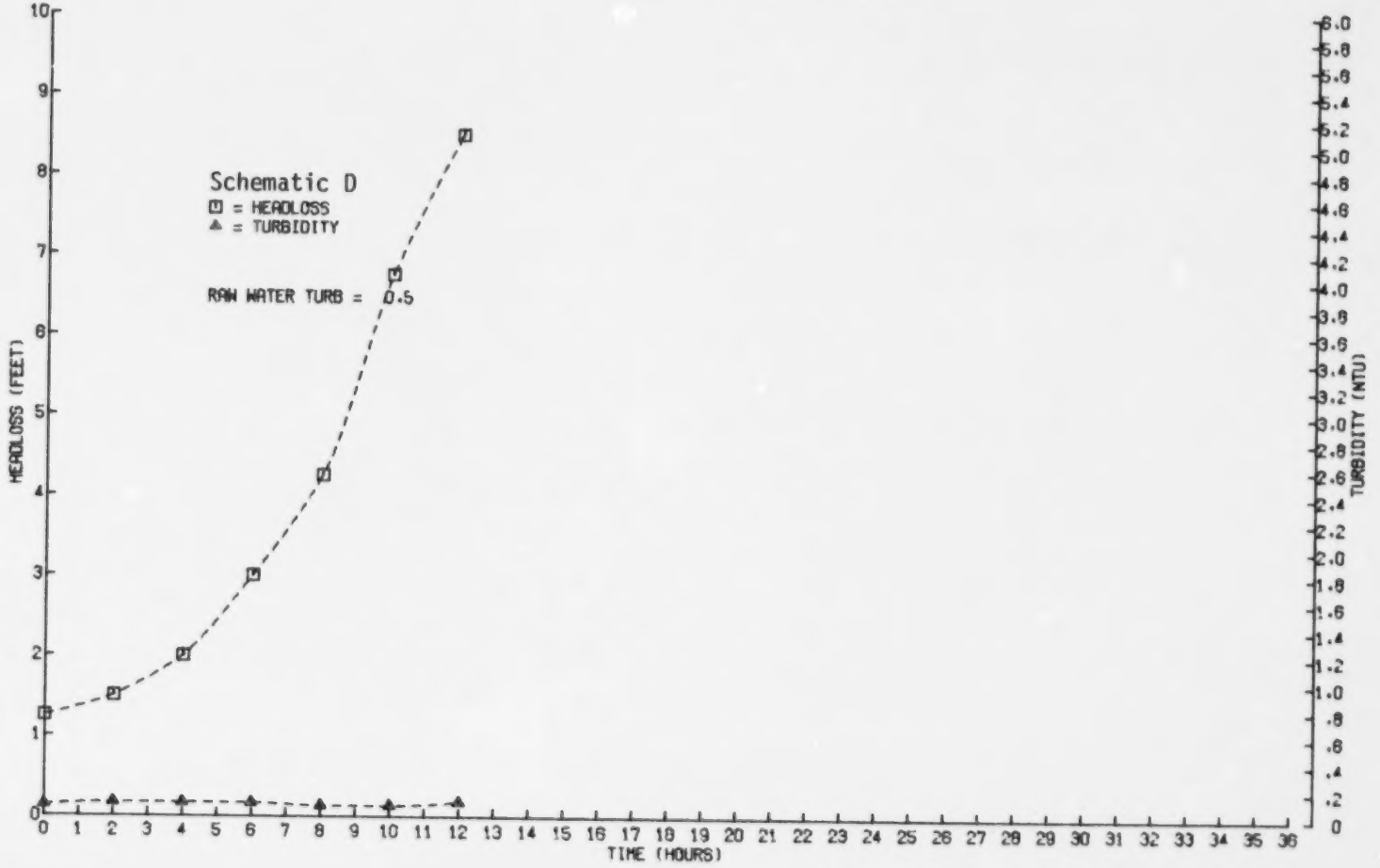


HEADLOSS AND TURBIDITY VS TIME

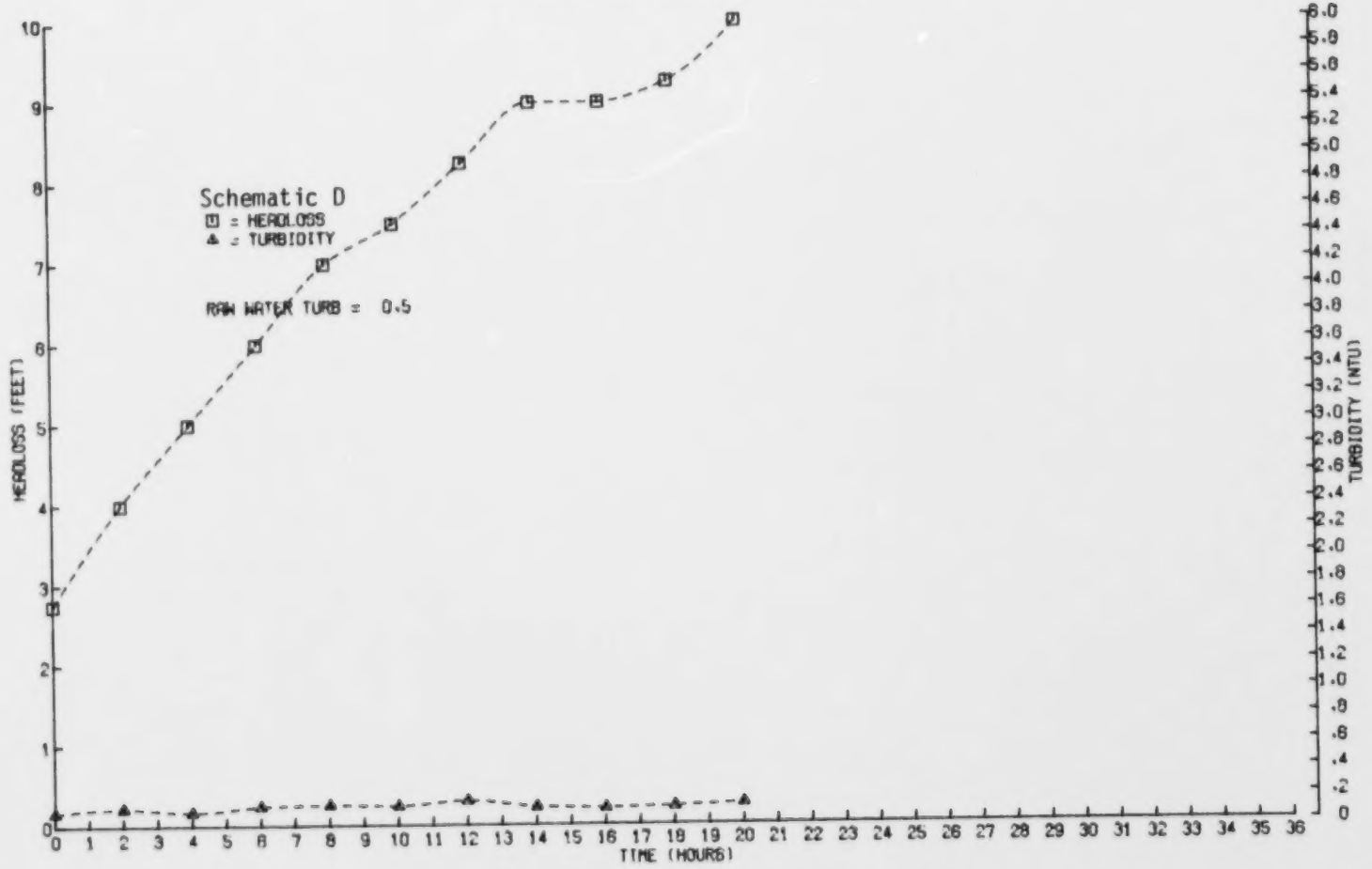
RUN NUMBER 154CC



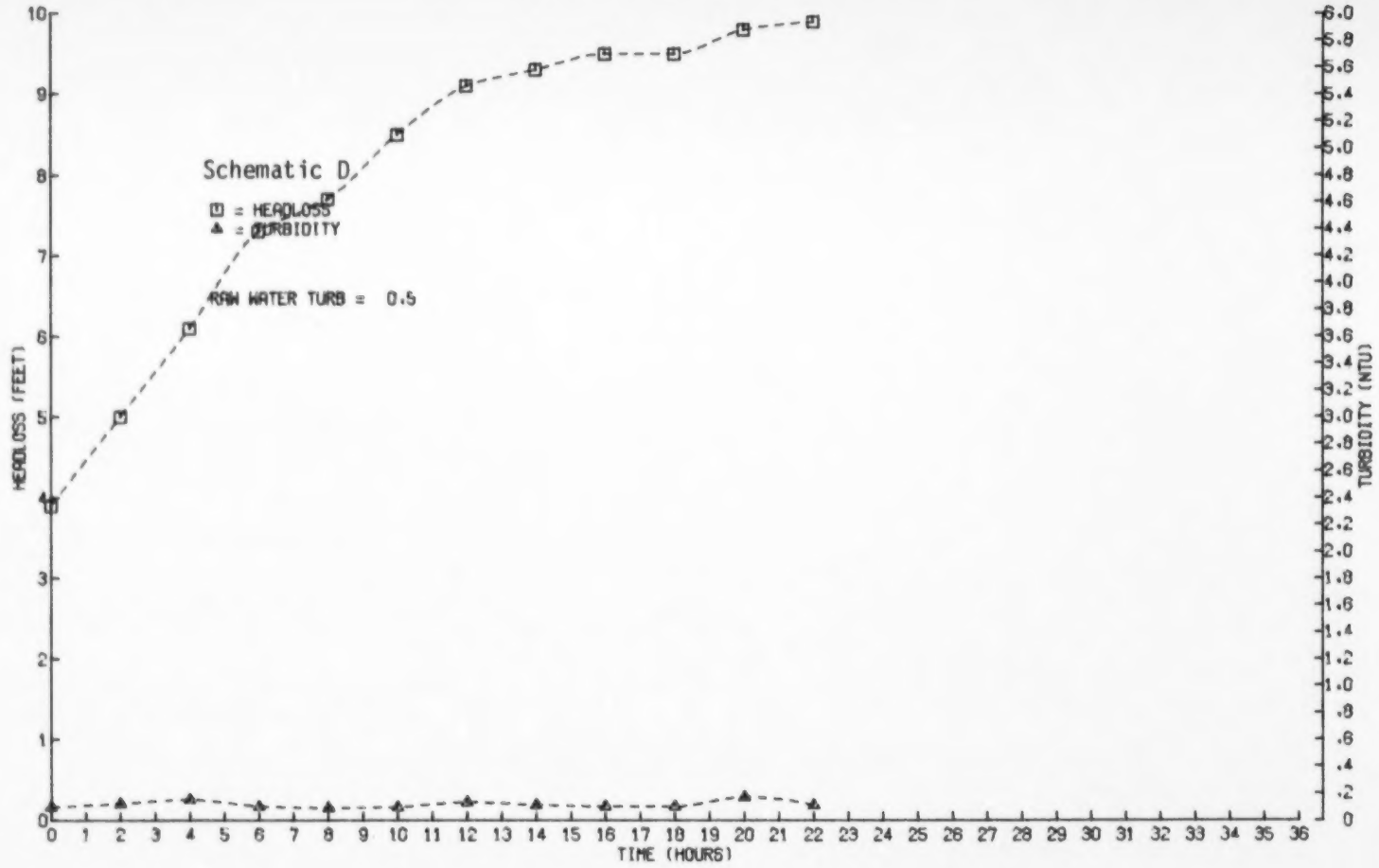
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 155



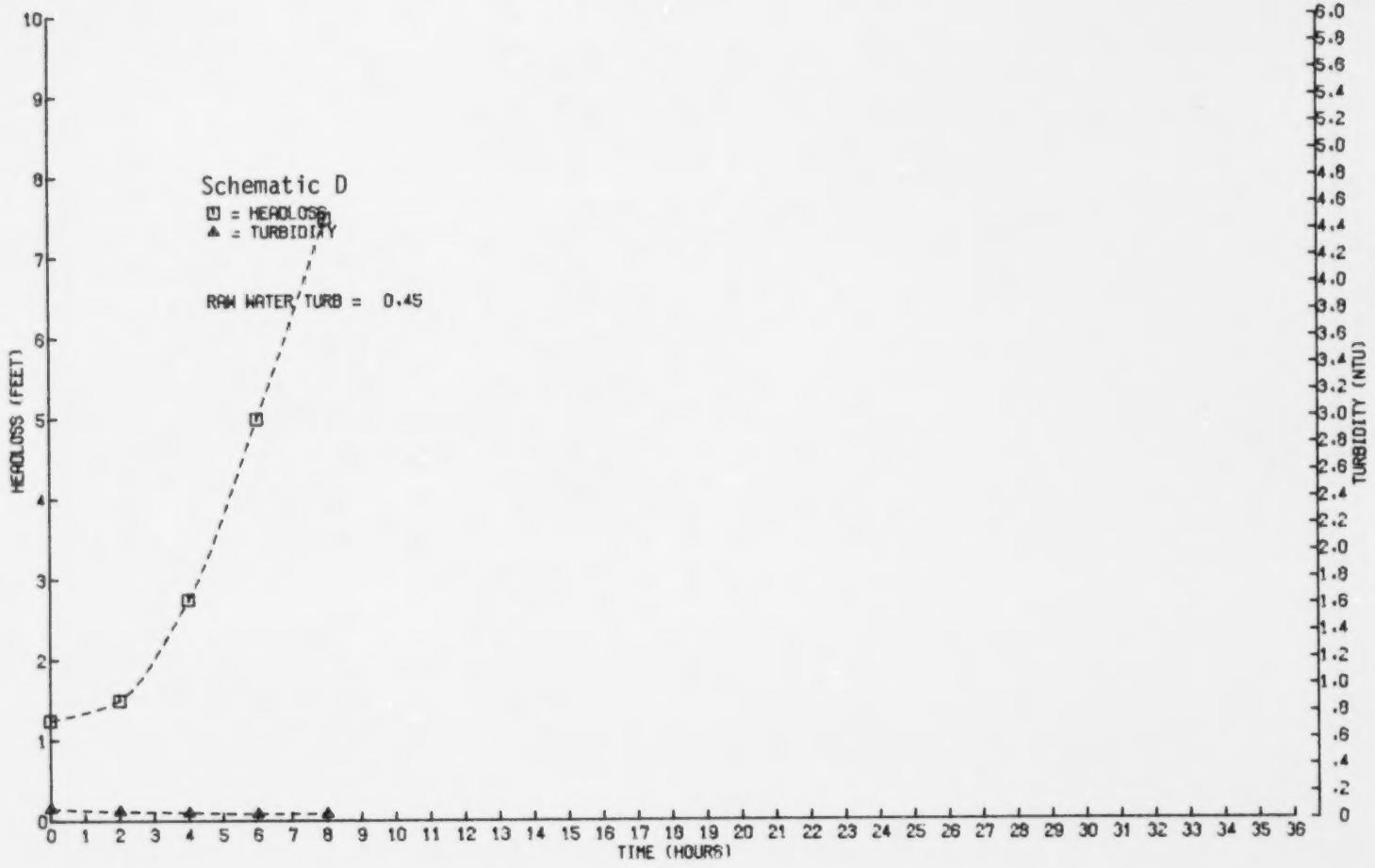
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 155M



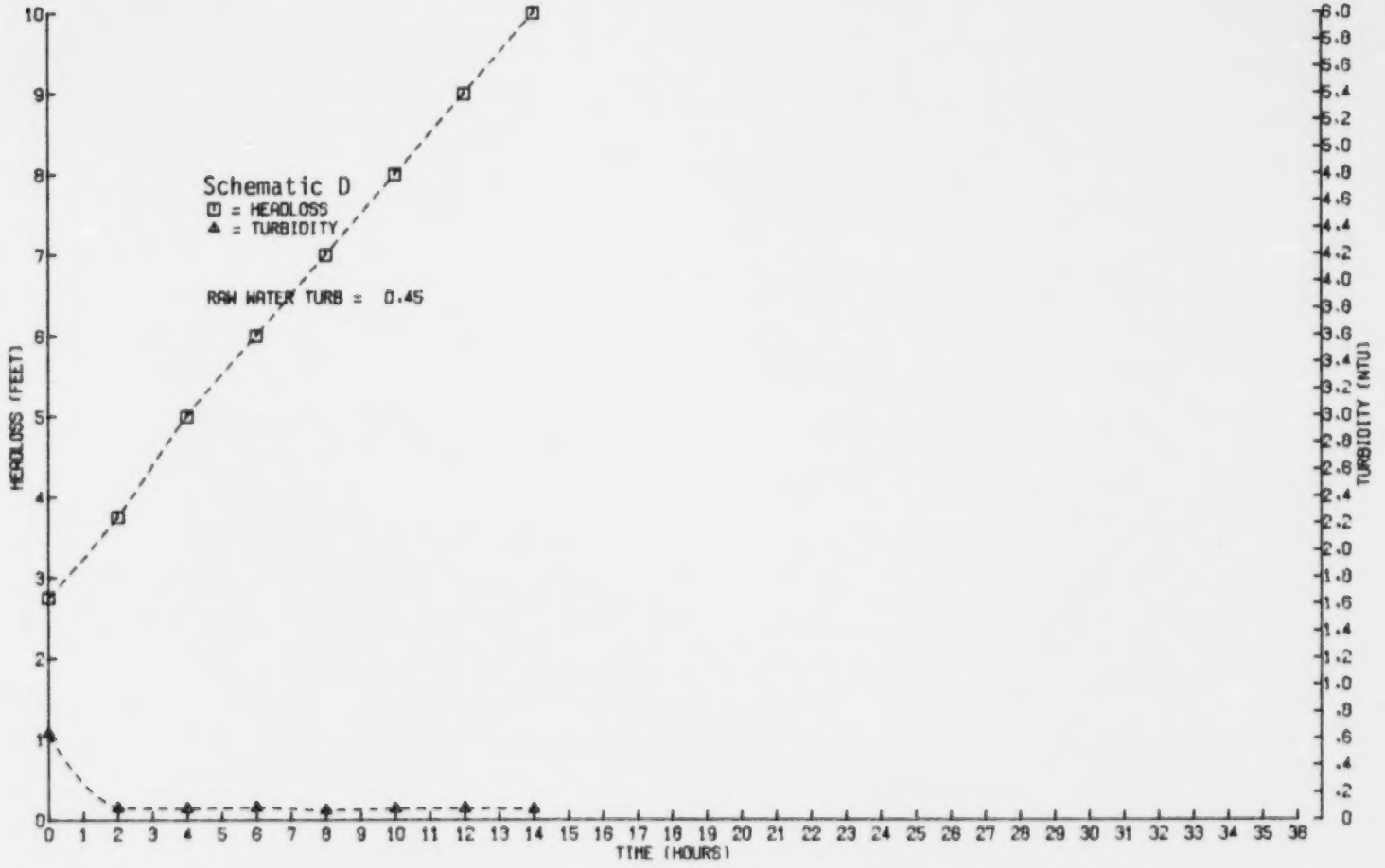
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 155C



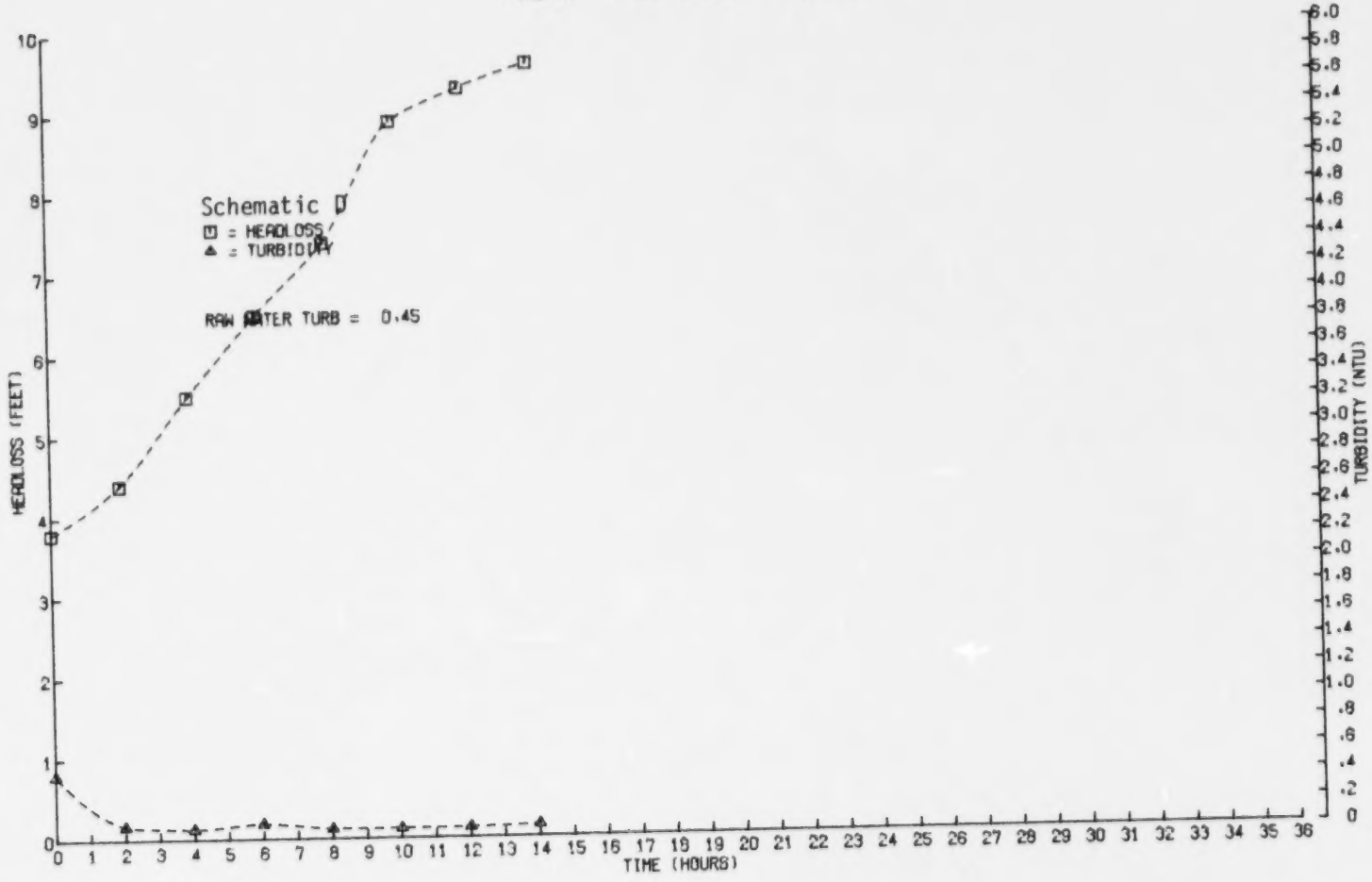
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 156



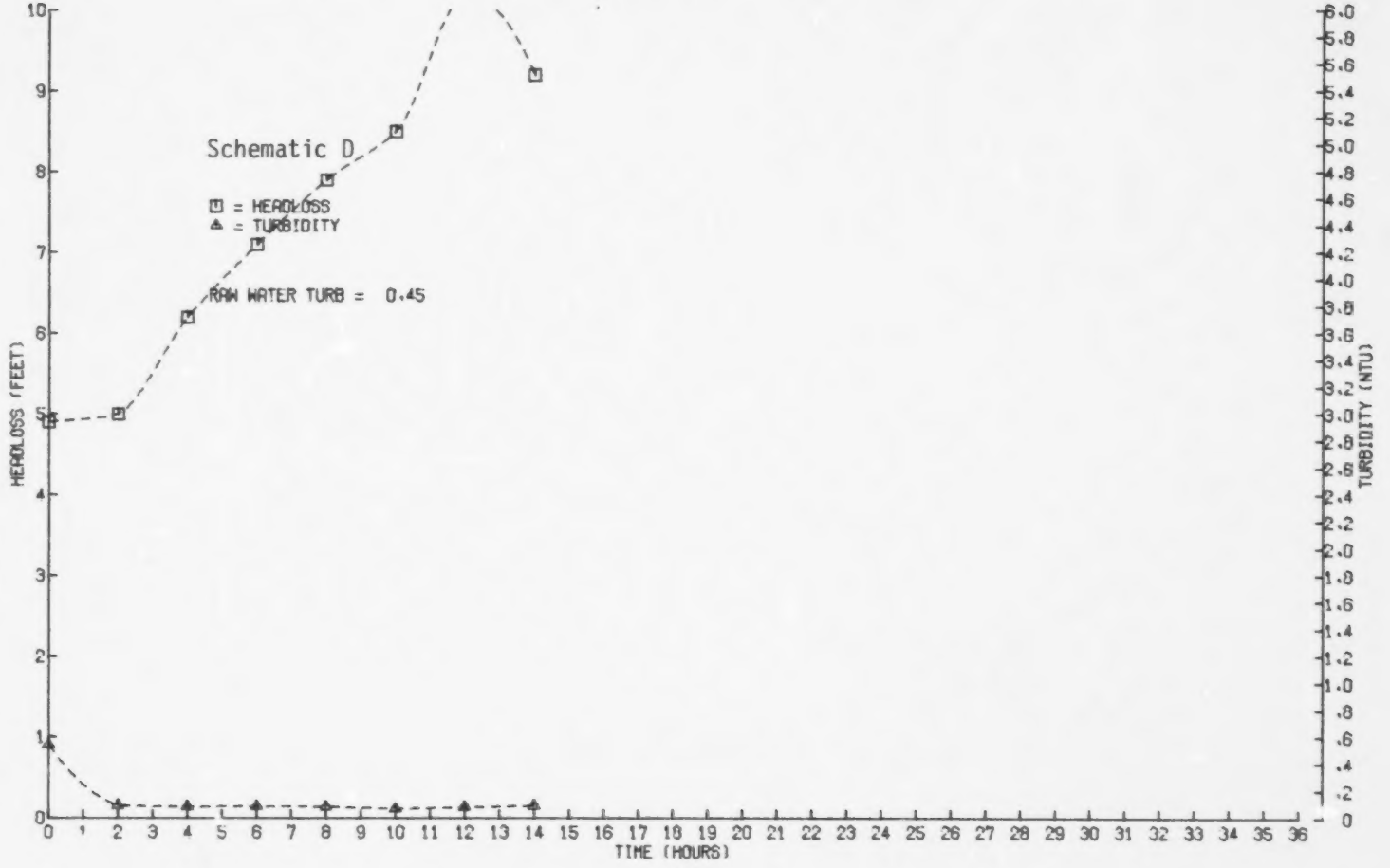
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 156M



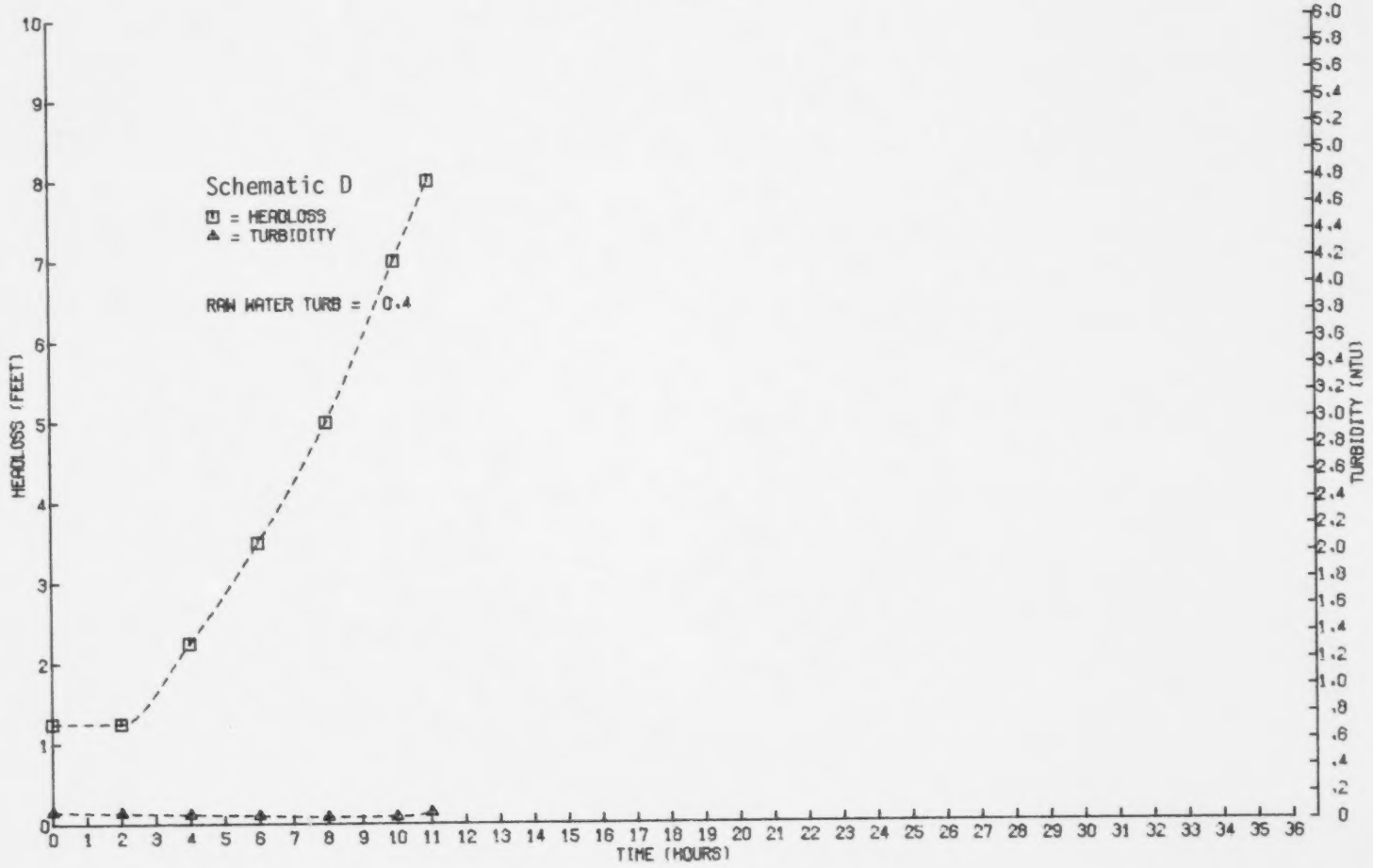
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 156F



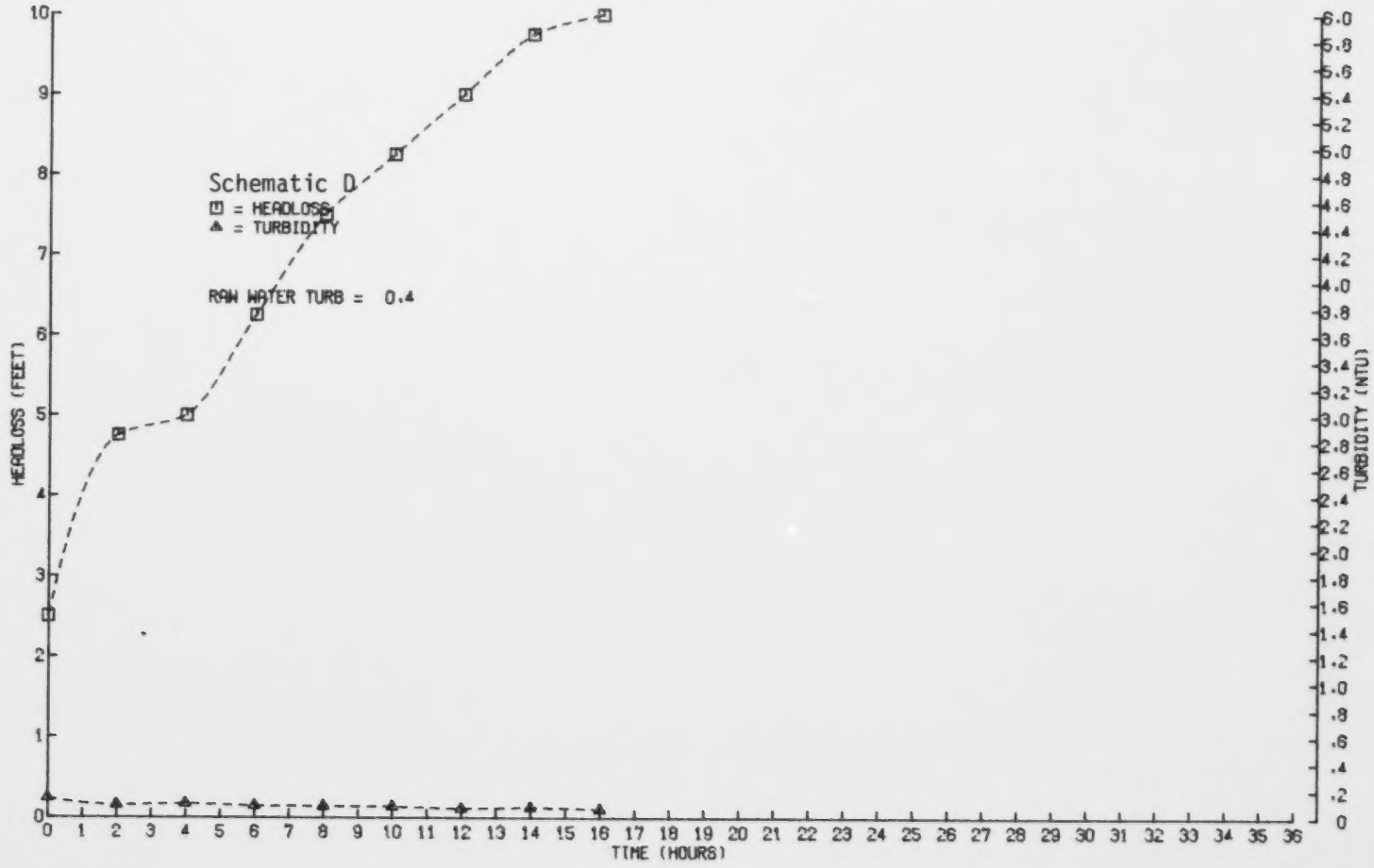
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 156C



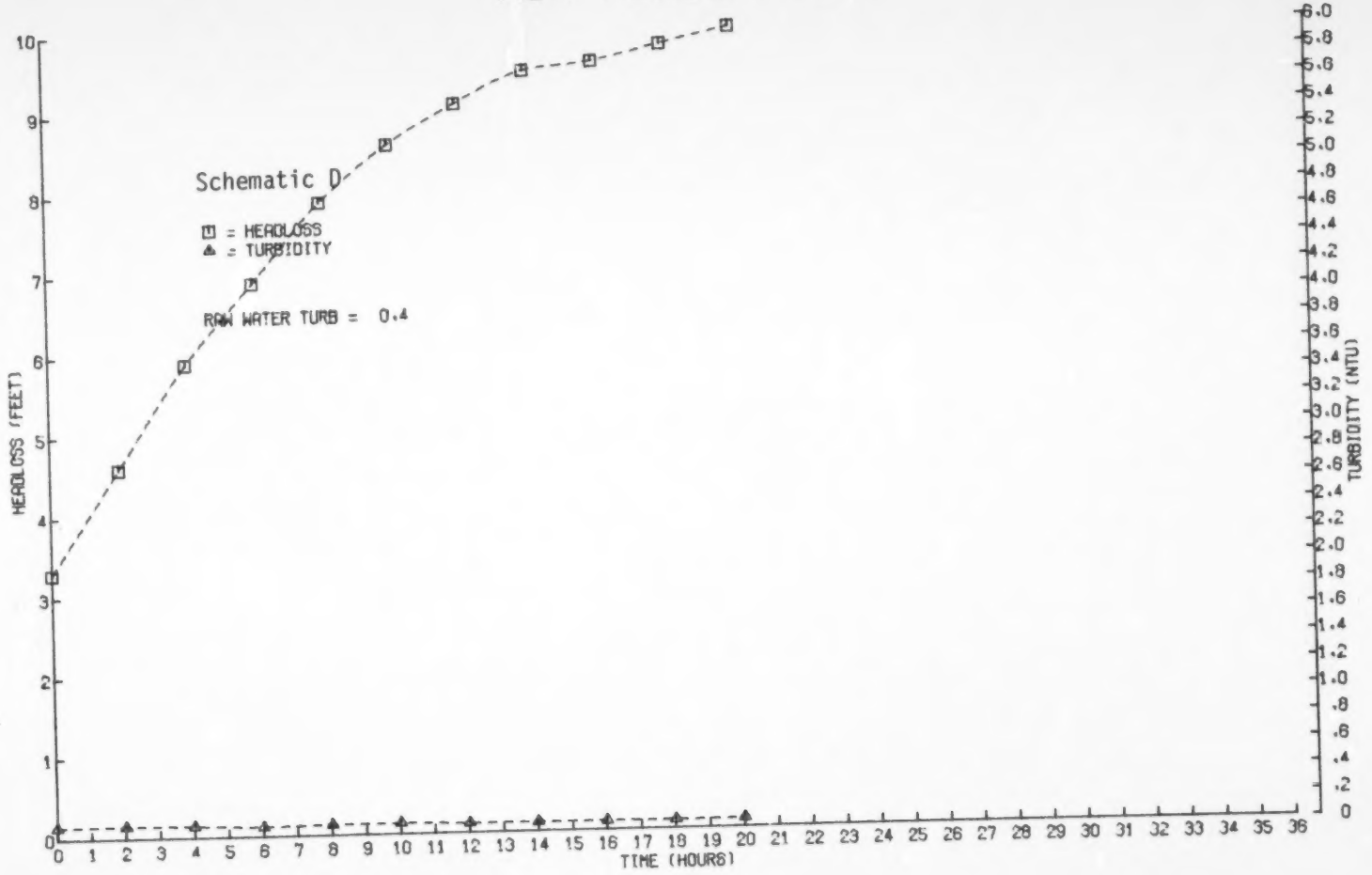
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 157



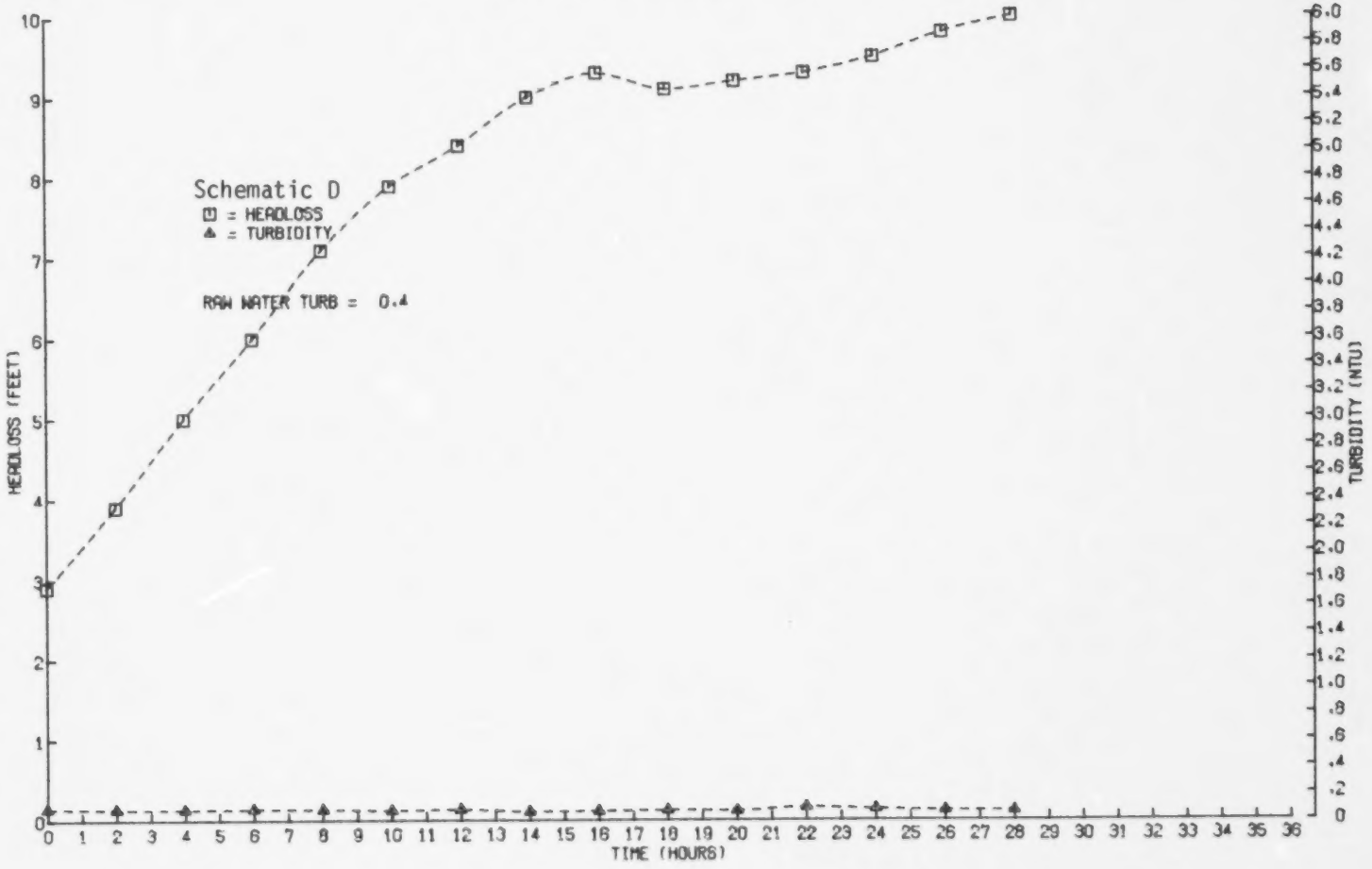
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 157M



HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 157F

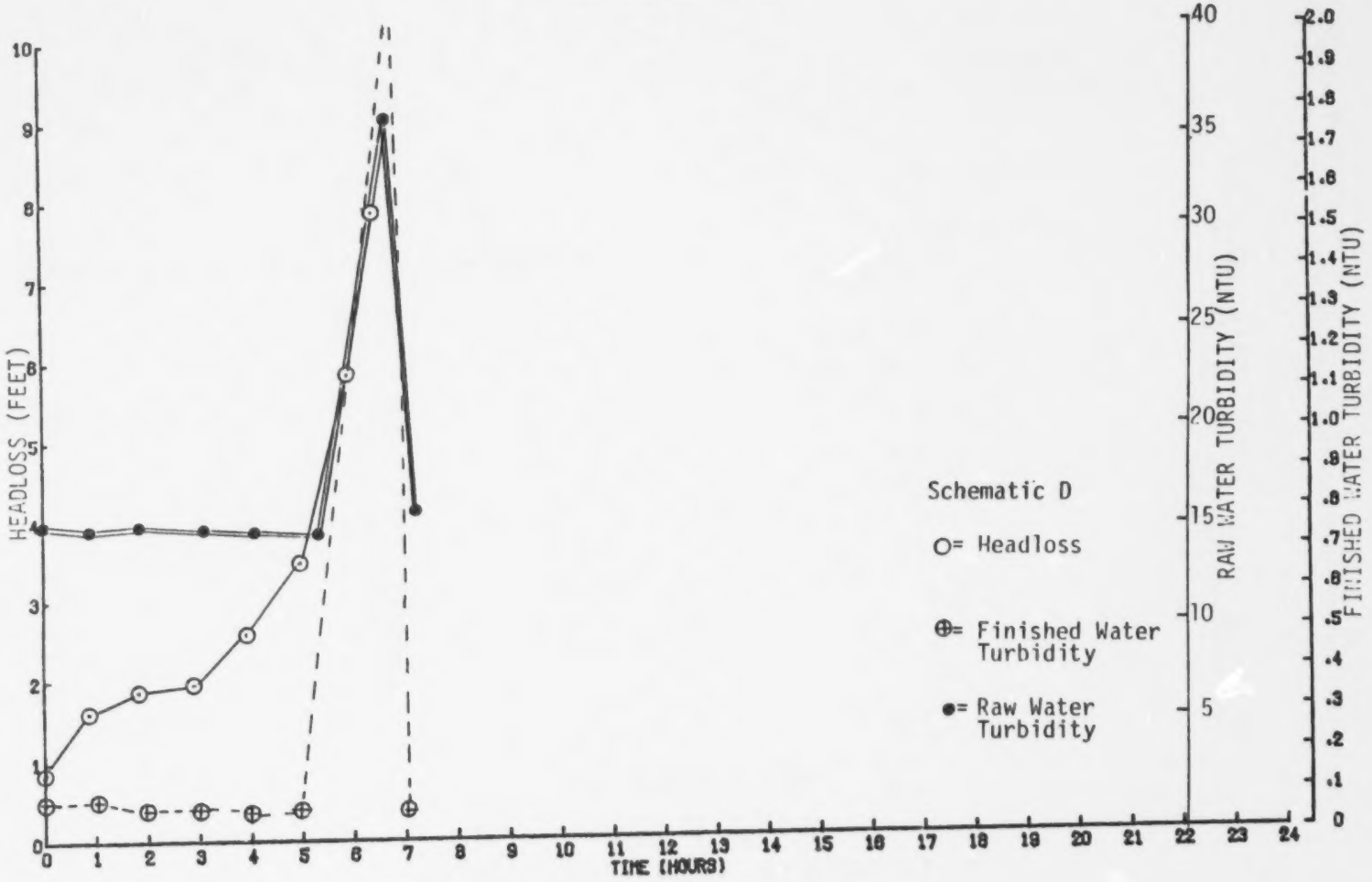


HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 157C



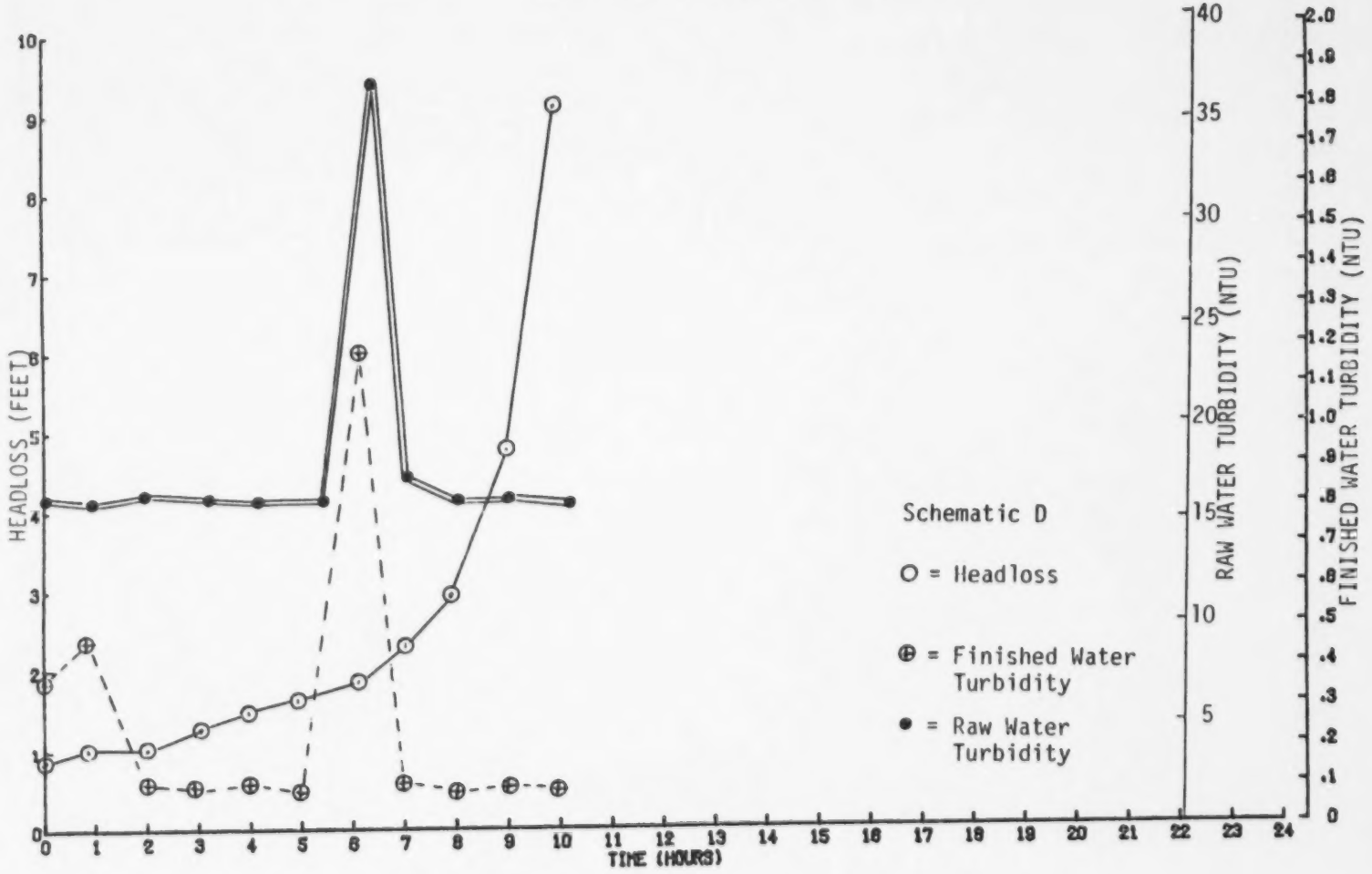
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 160



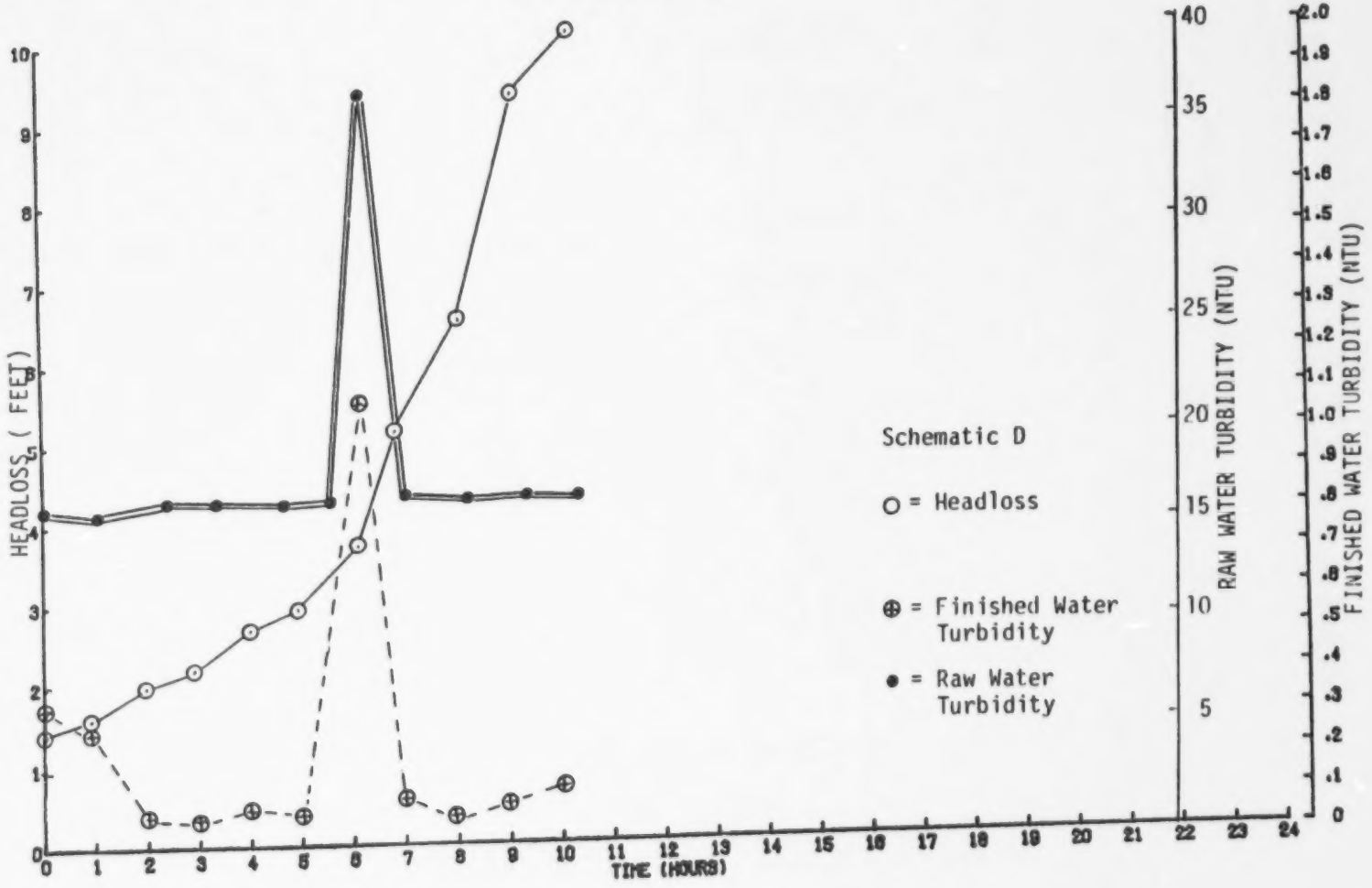
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 160MM



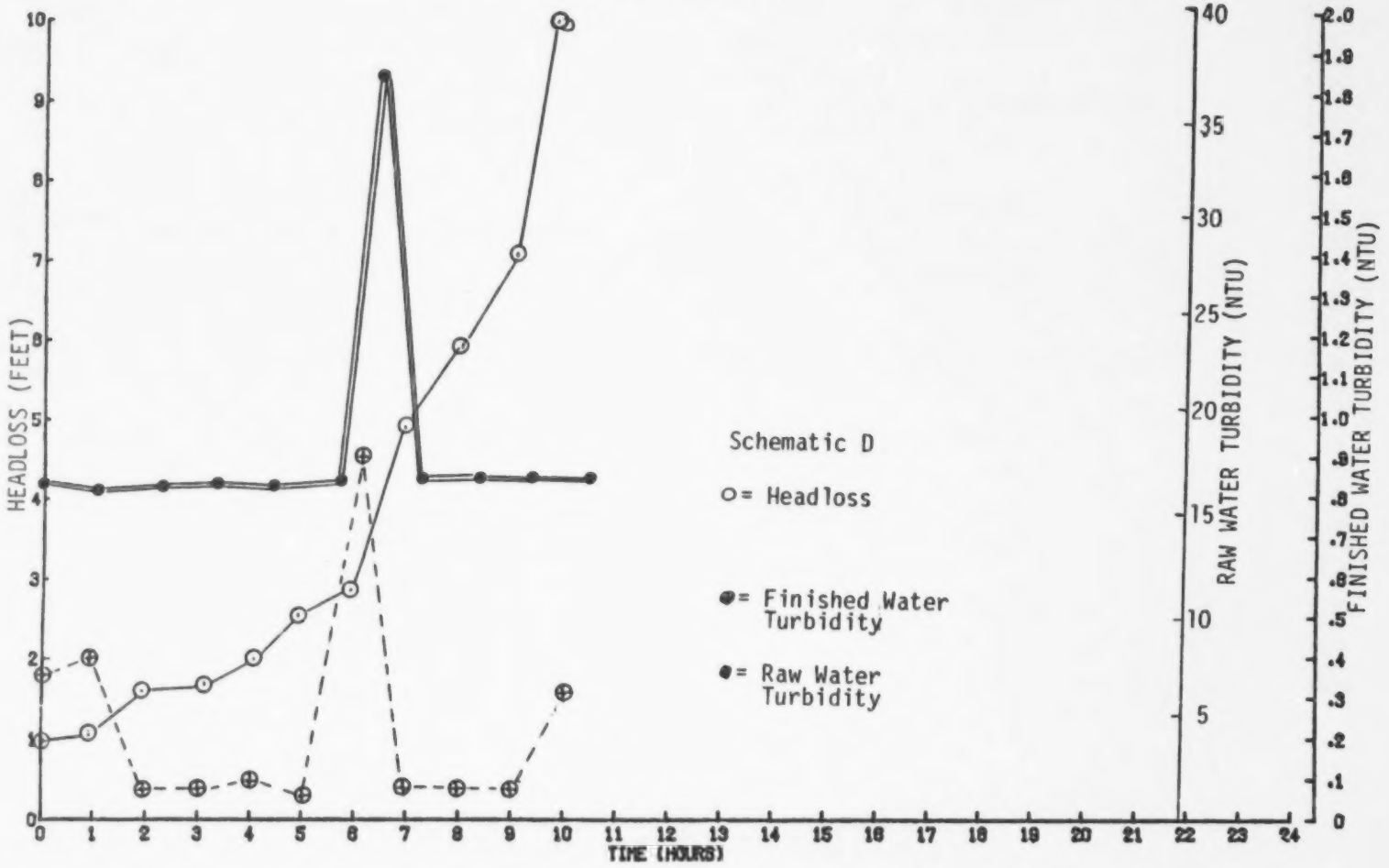
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 160FC

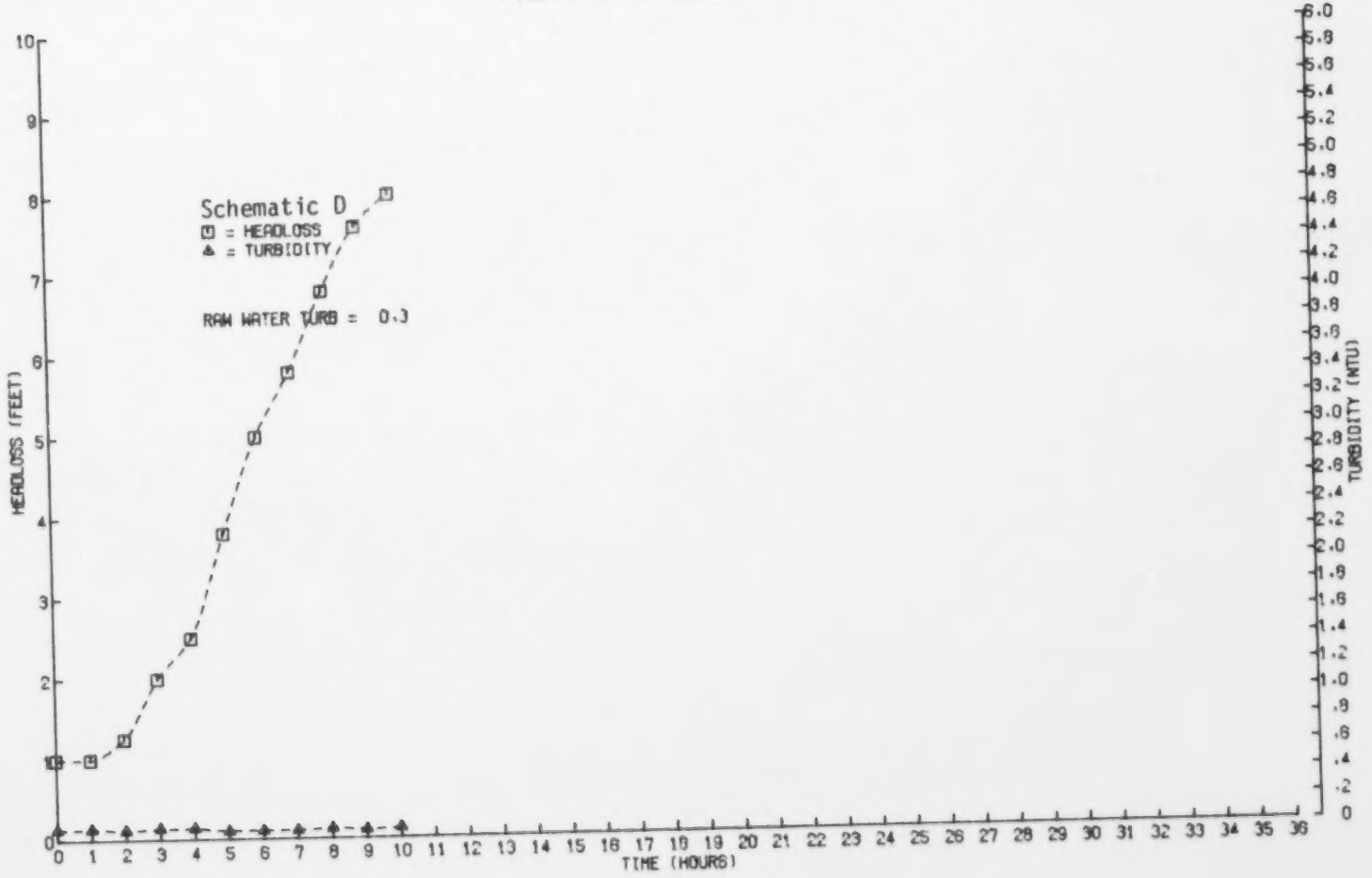


HEADLOSS AND TURBIDITY VS TIME

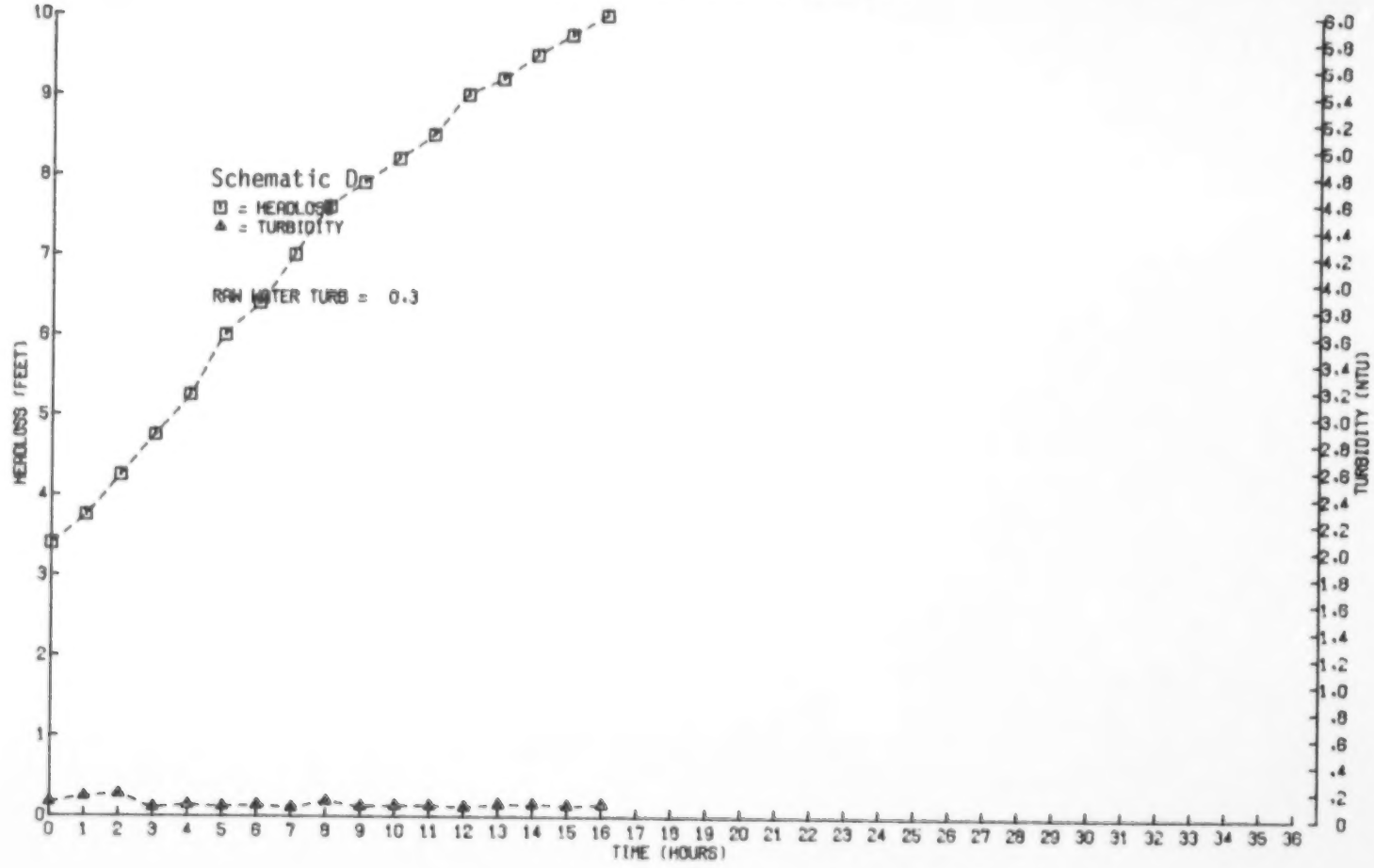
RUN NUMBER 160CC



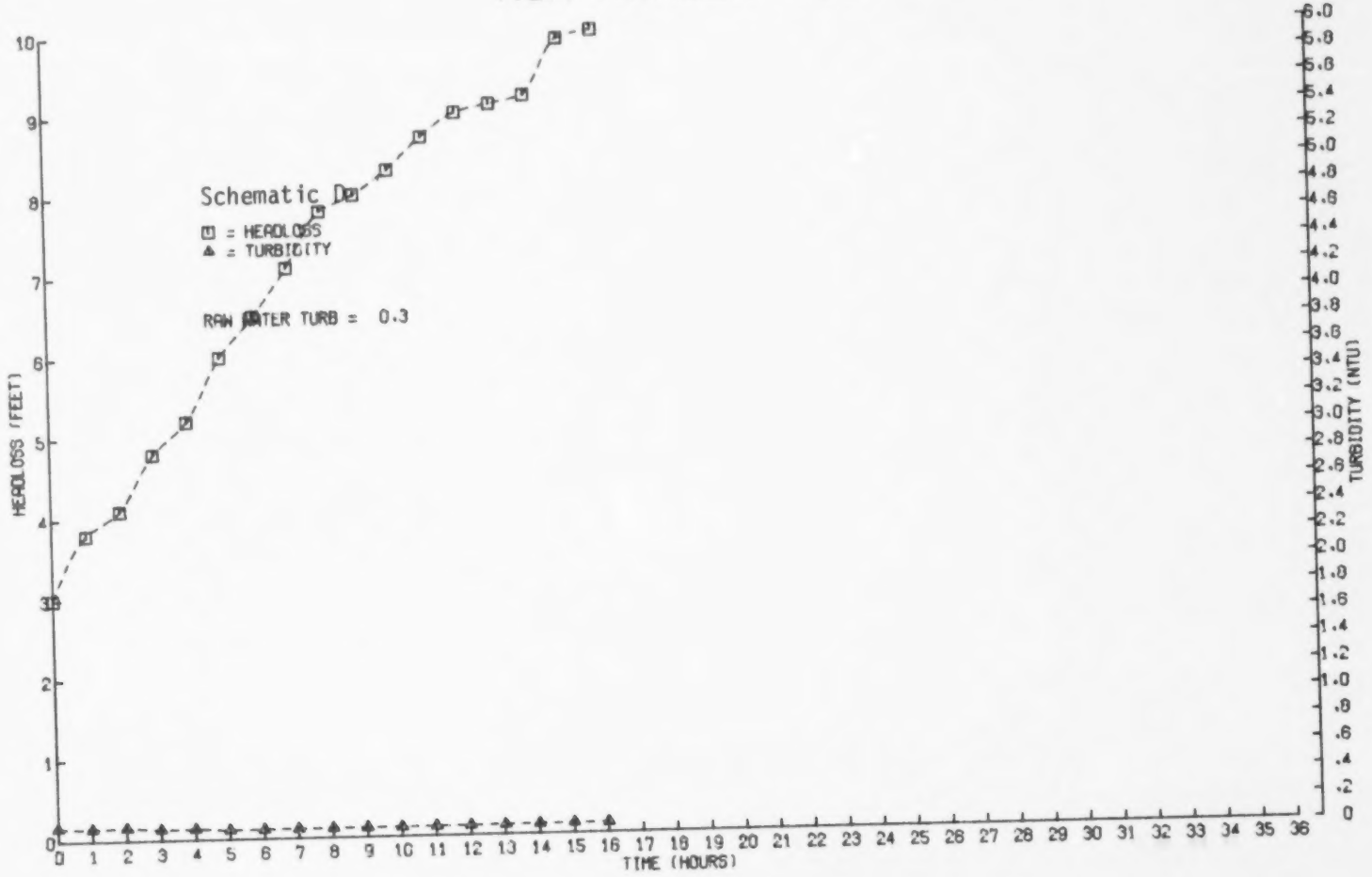
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 161



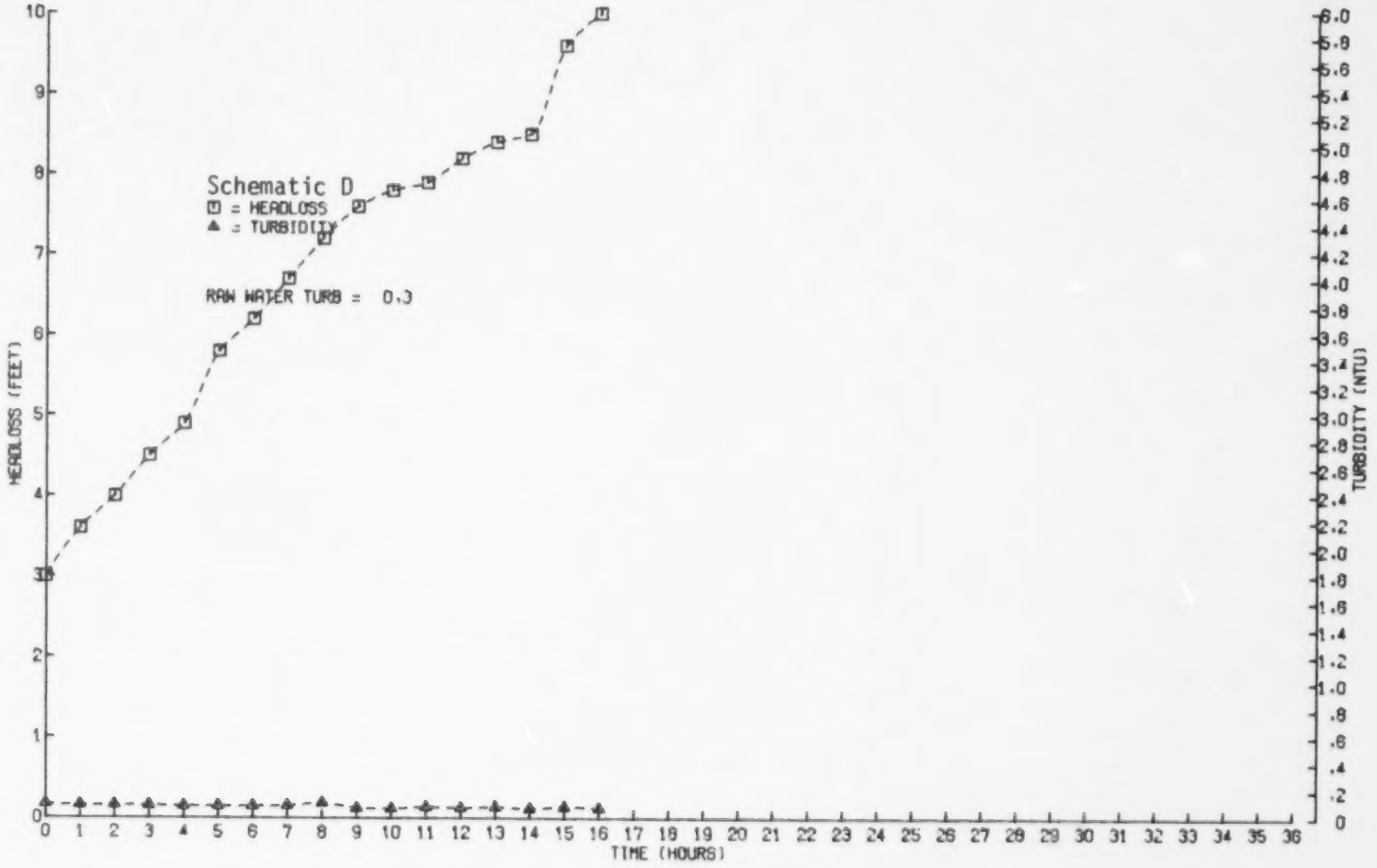
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 161M



HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 161F

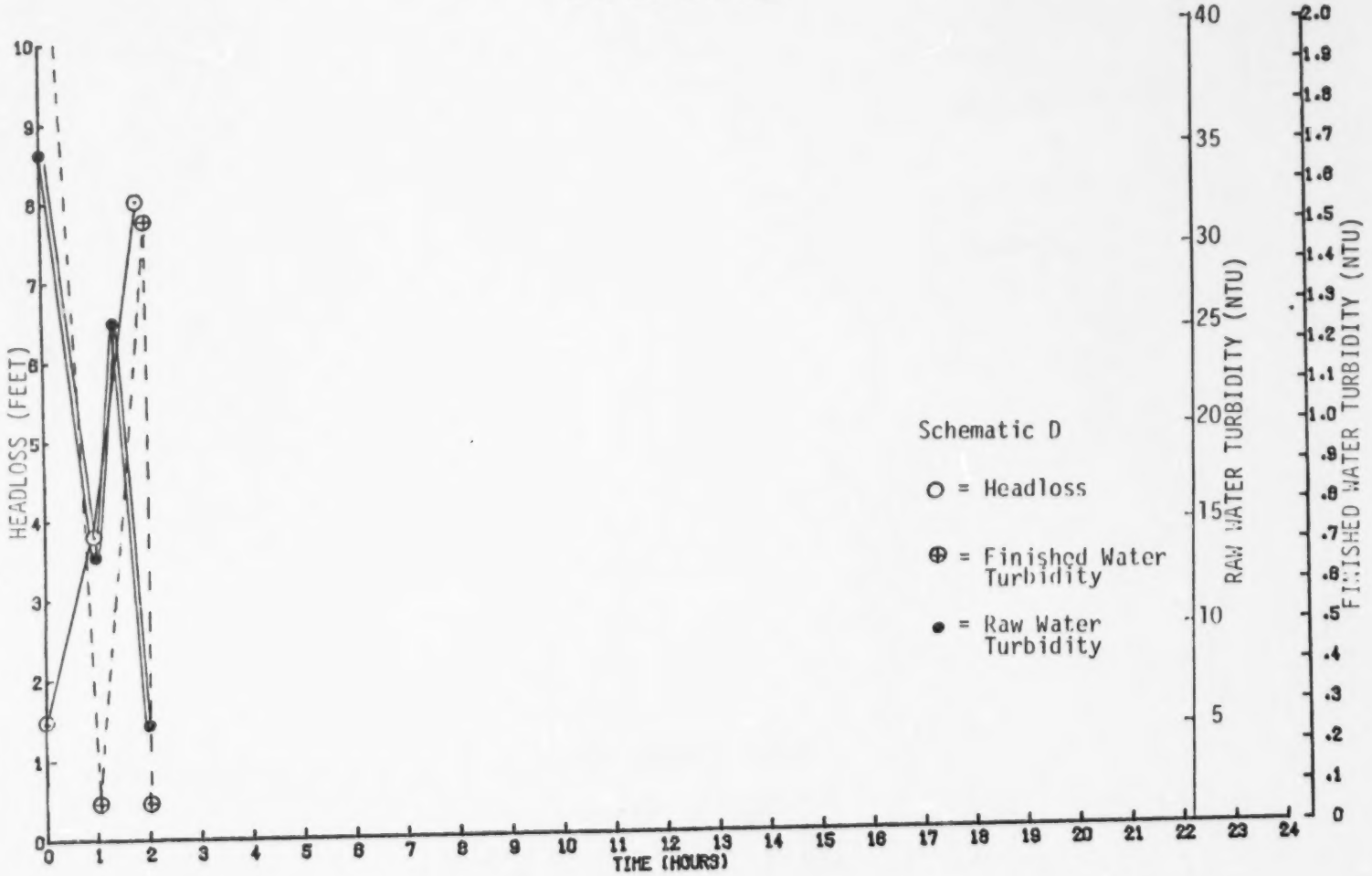


HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 161C



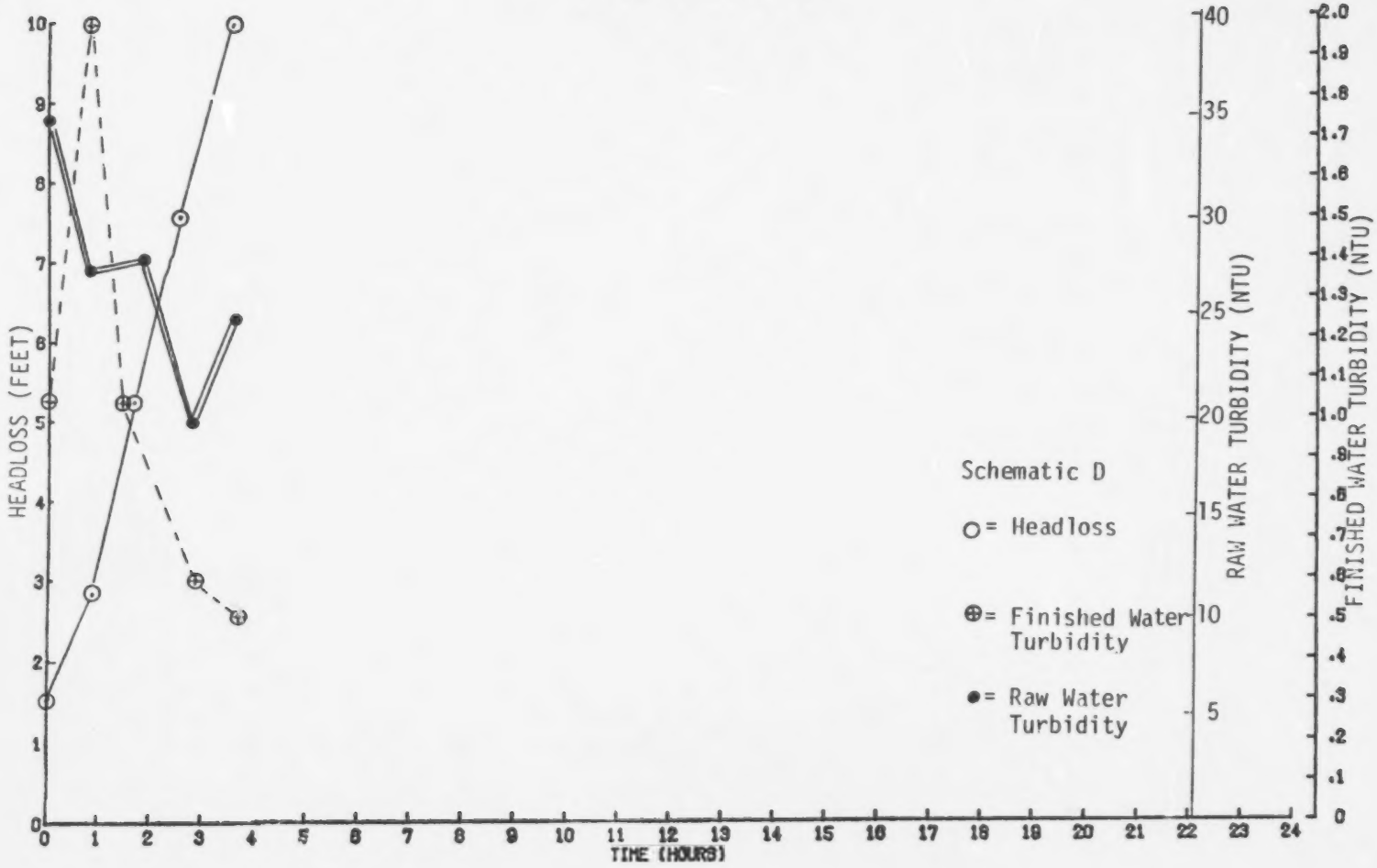
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 162



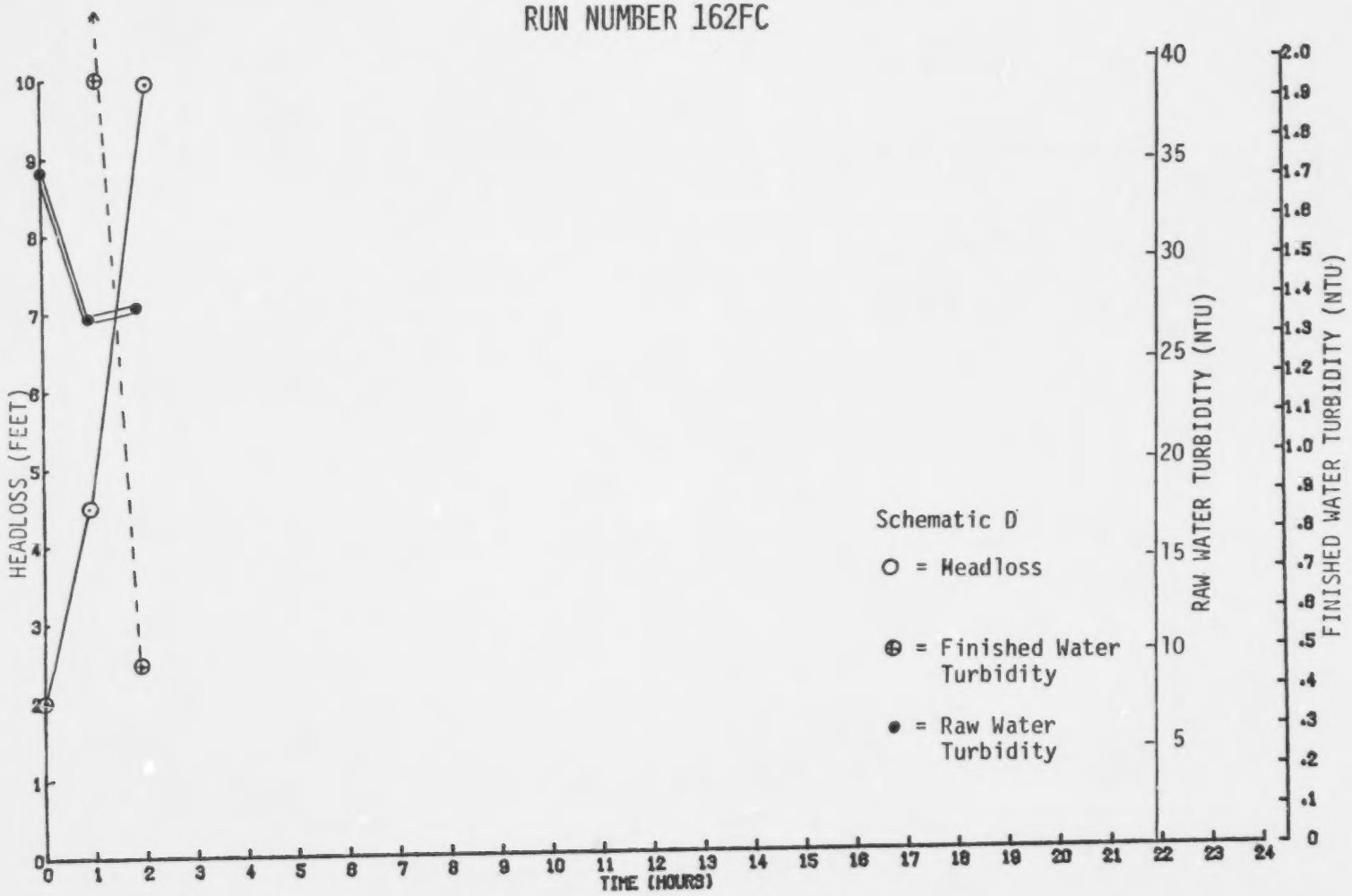
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 162MM



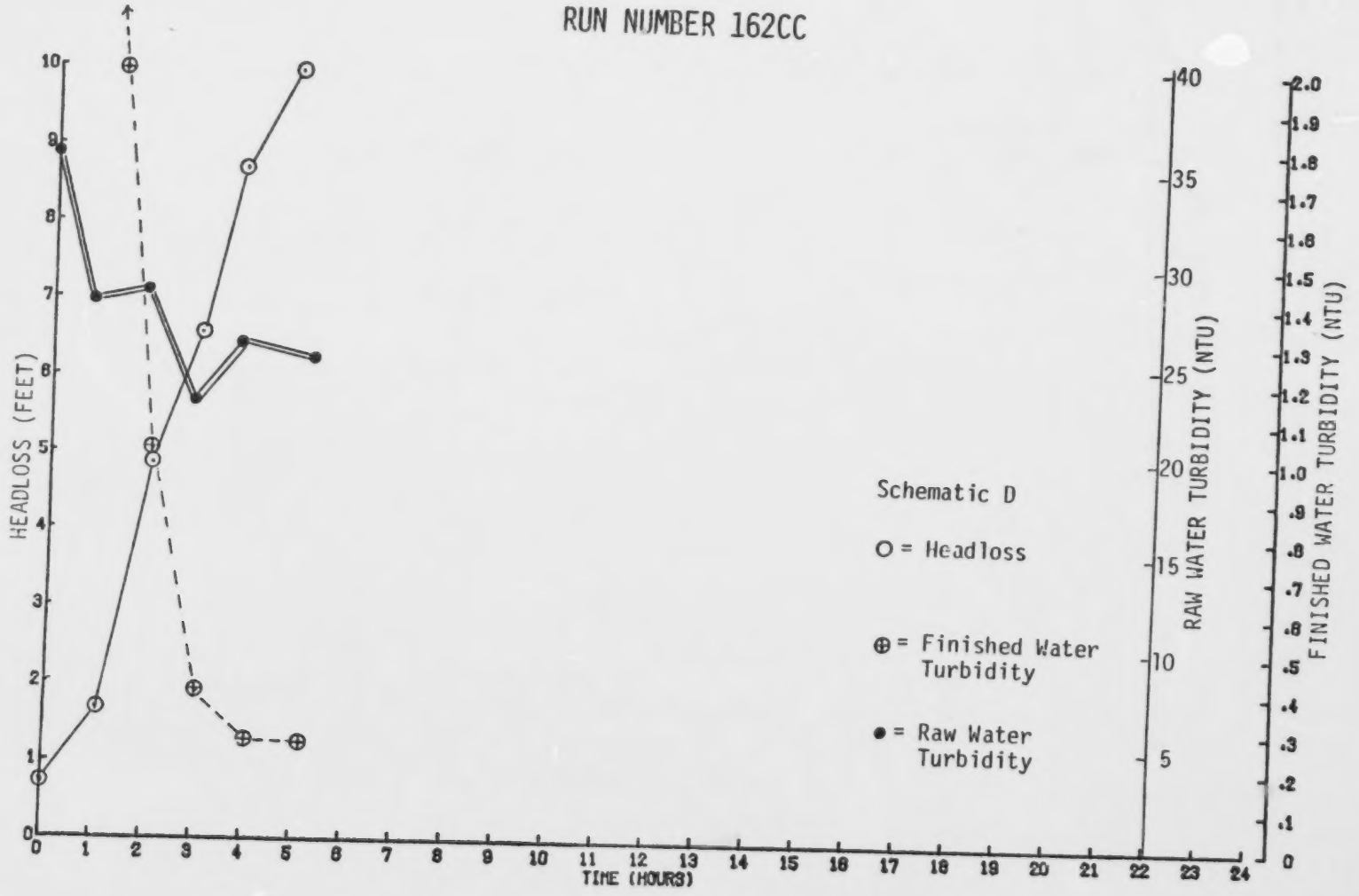
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 162FC



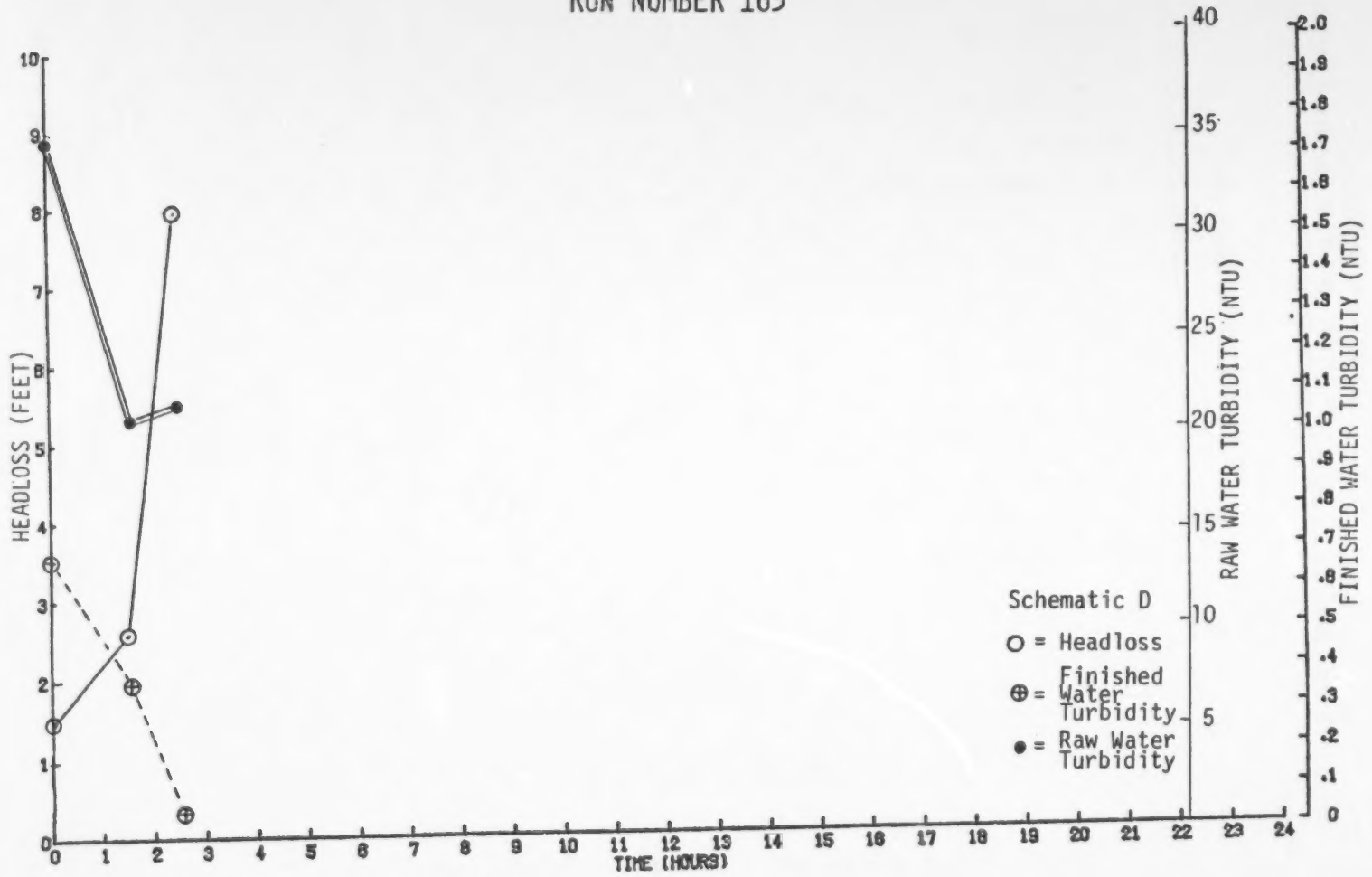
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 162CC



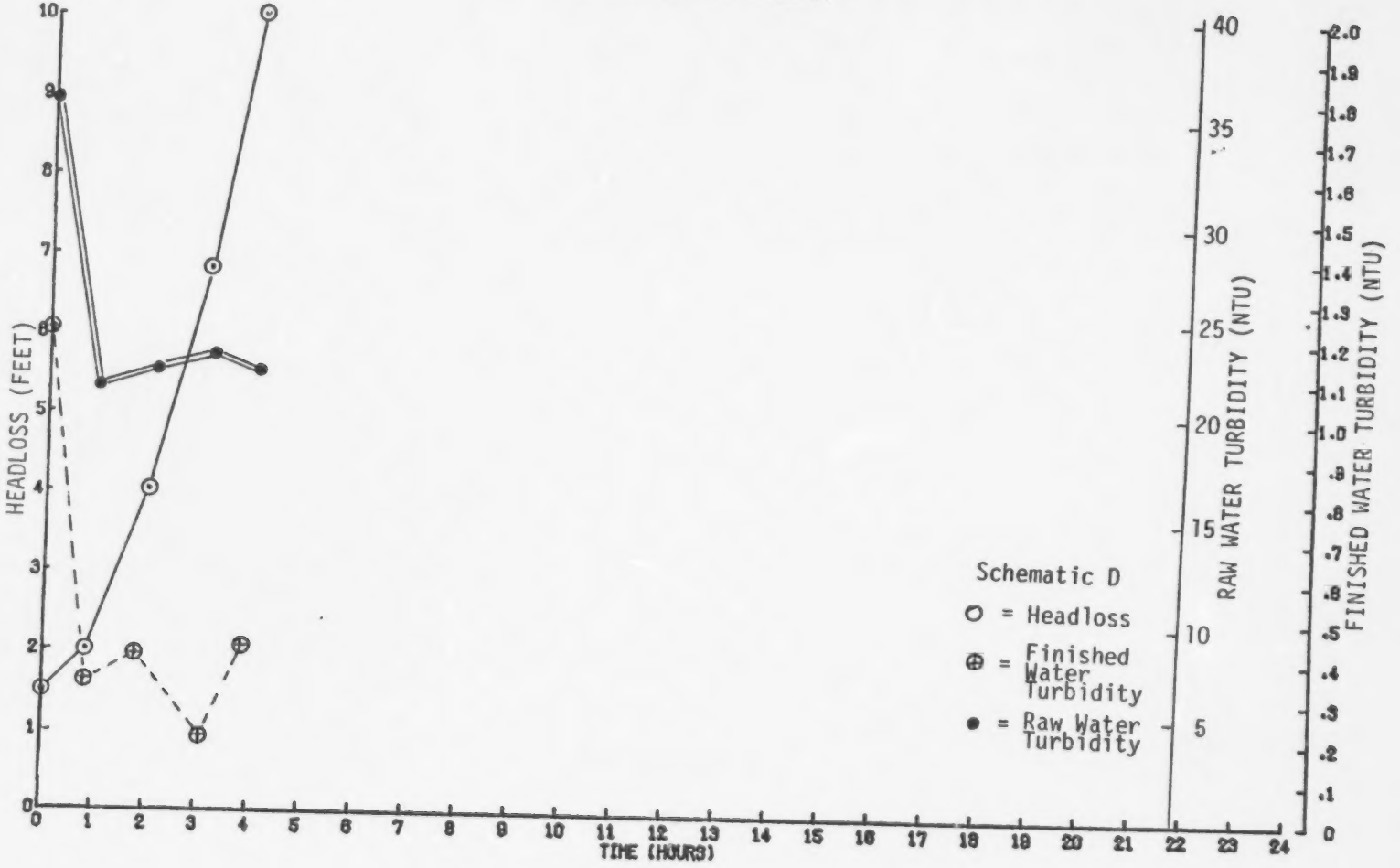
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 163



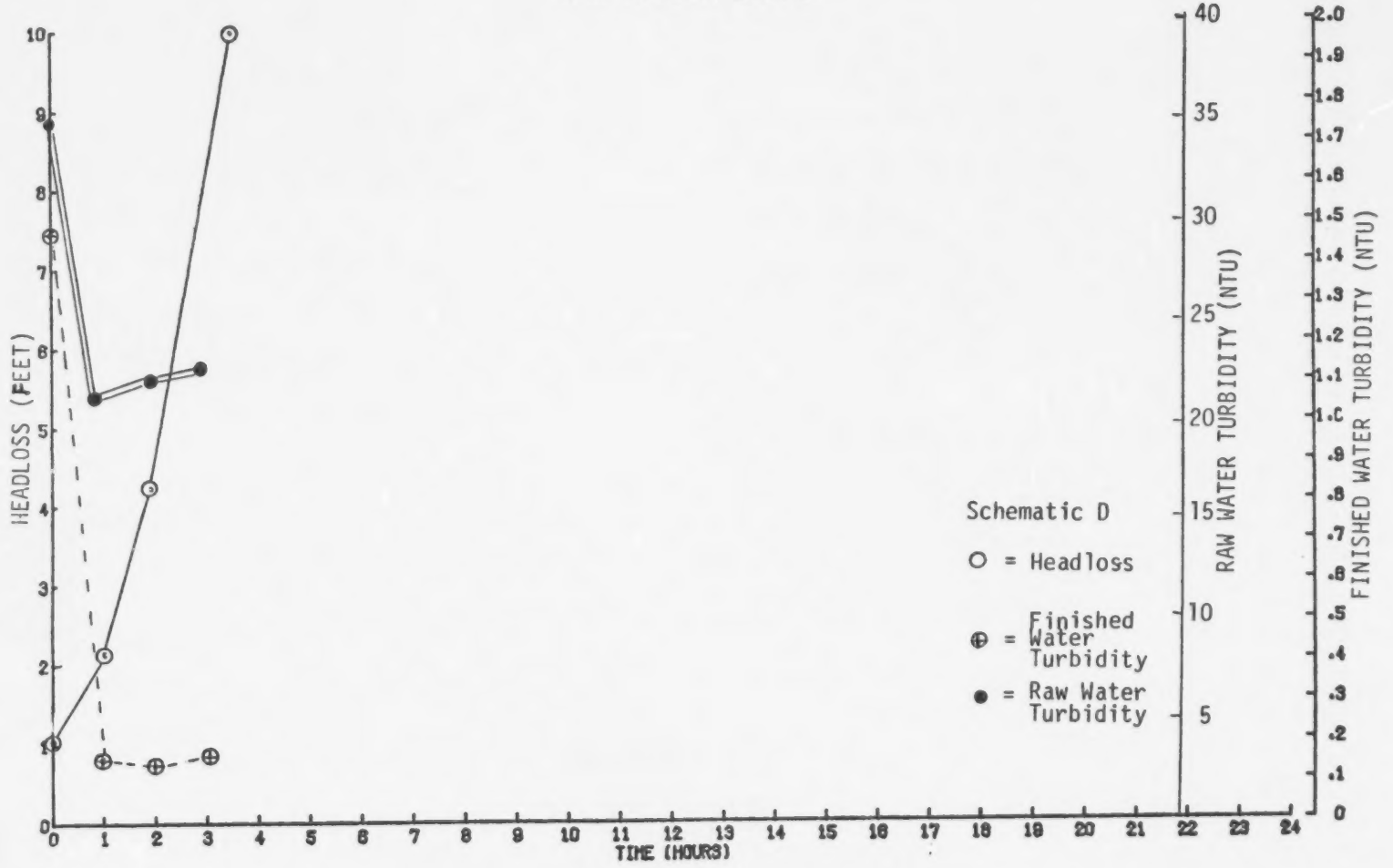
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 163MM



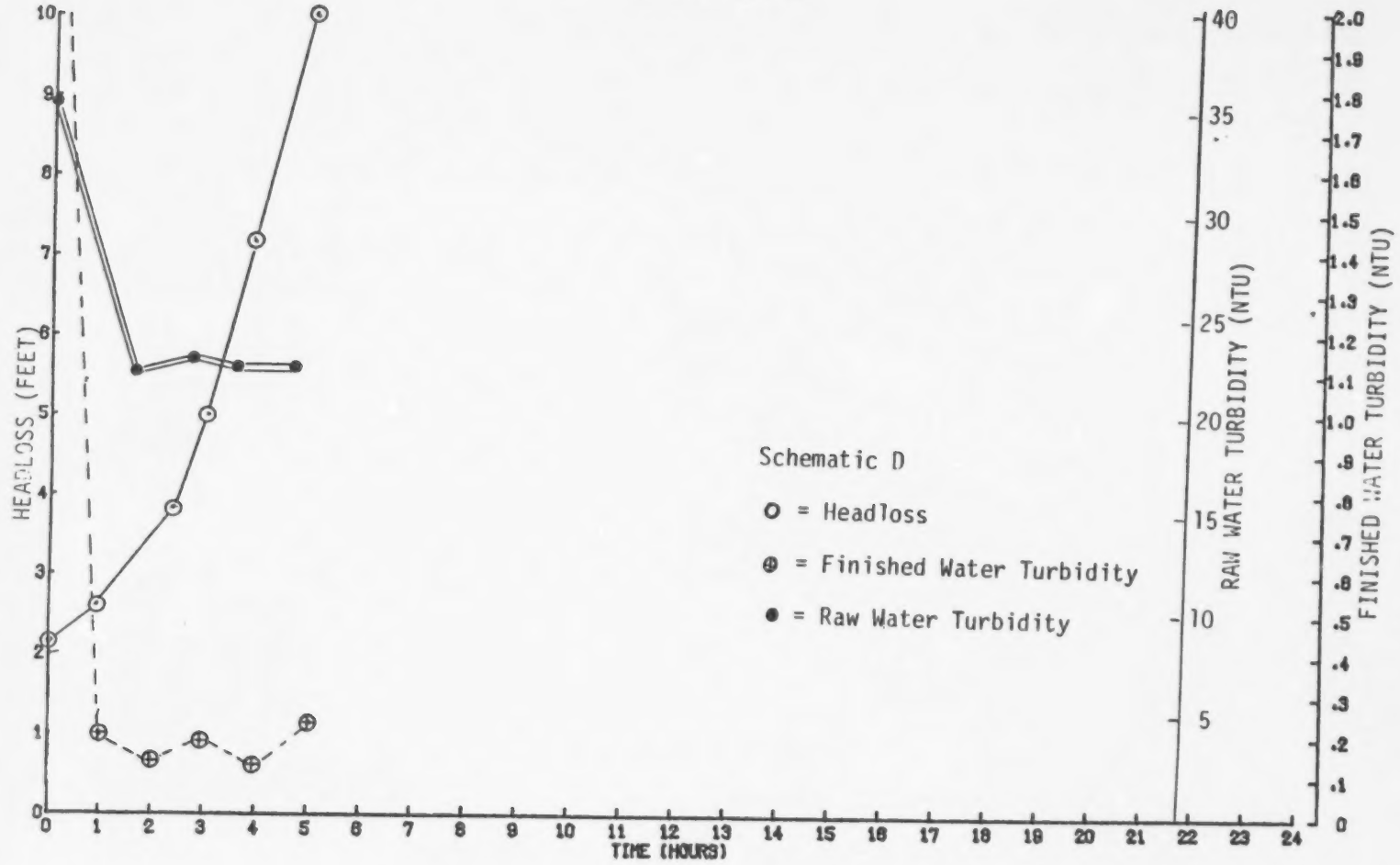
HEADLOSS AND TURBIDITY VS TIME

RUN NUMBER 163FC

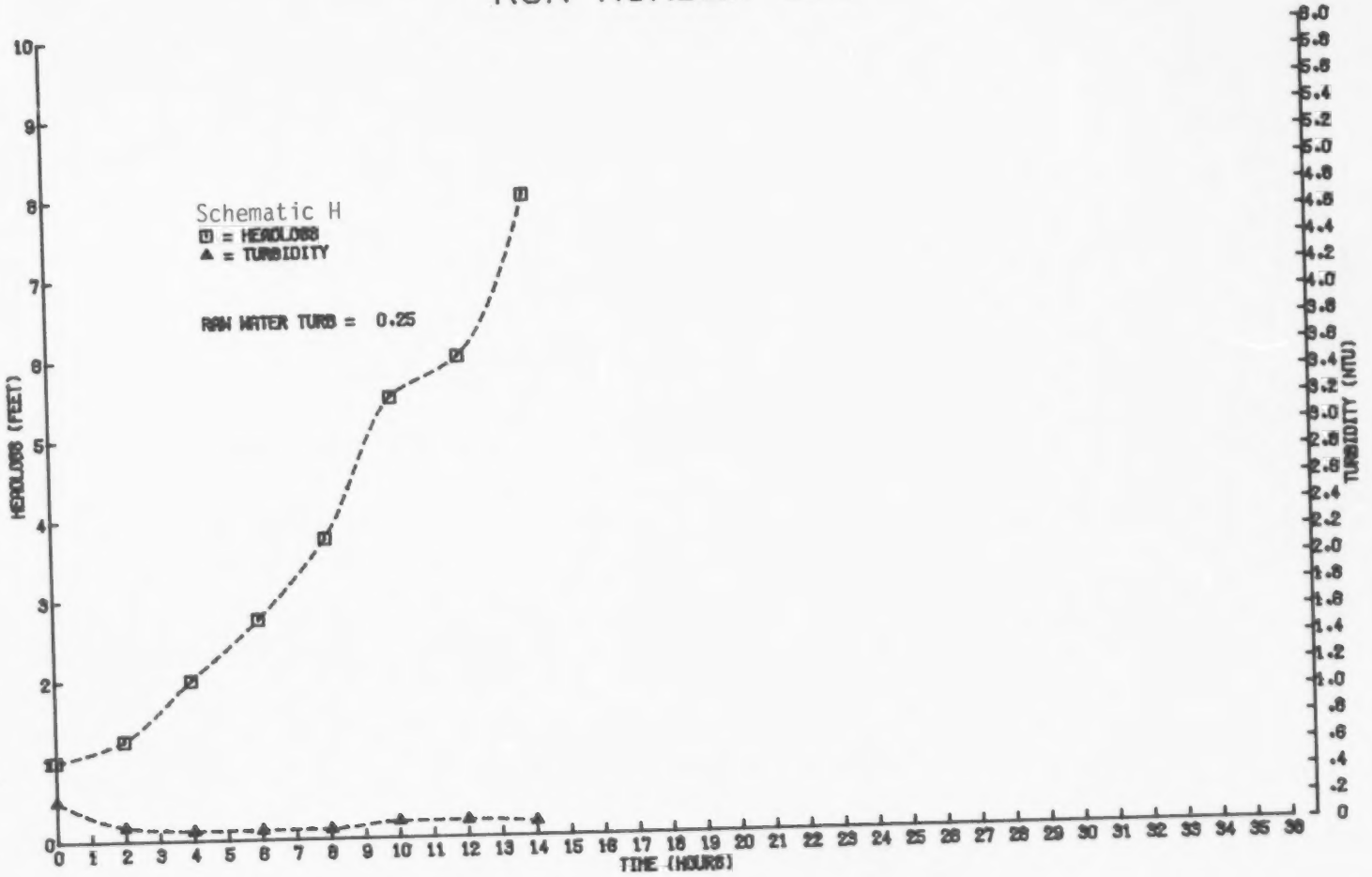


HEADLOSS AND TURBIDITY VS TIME

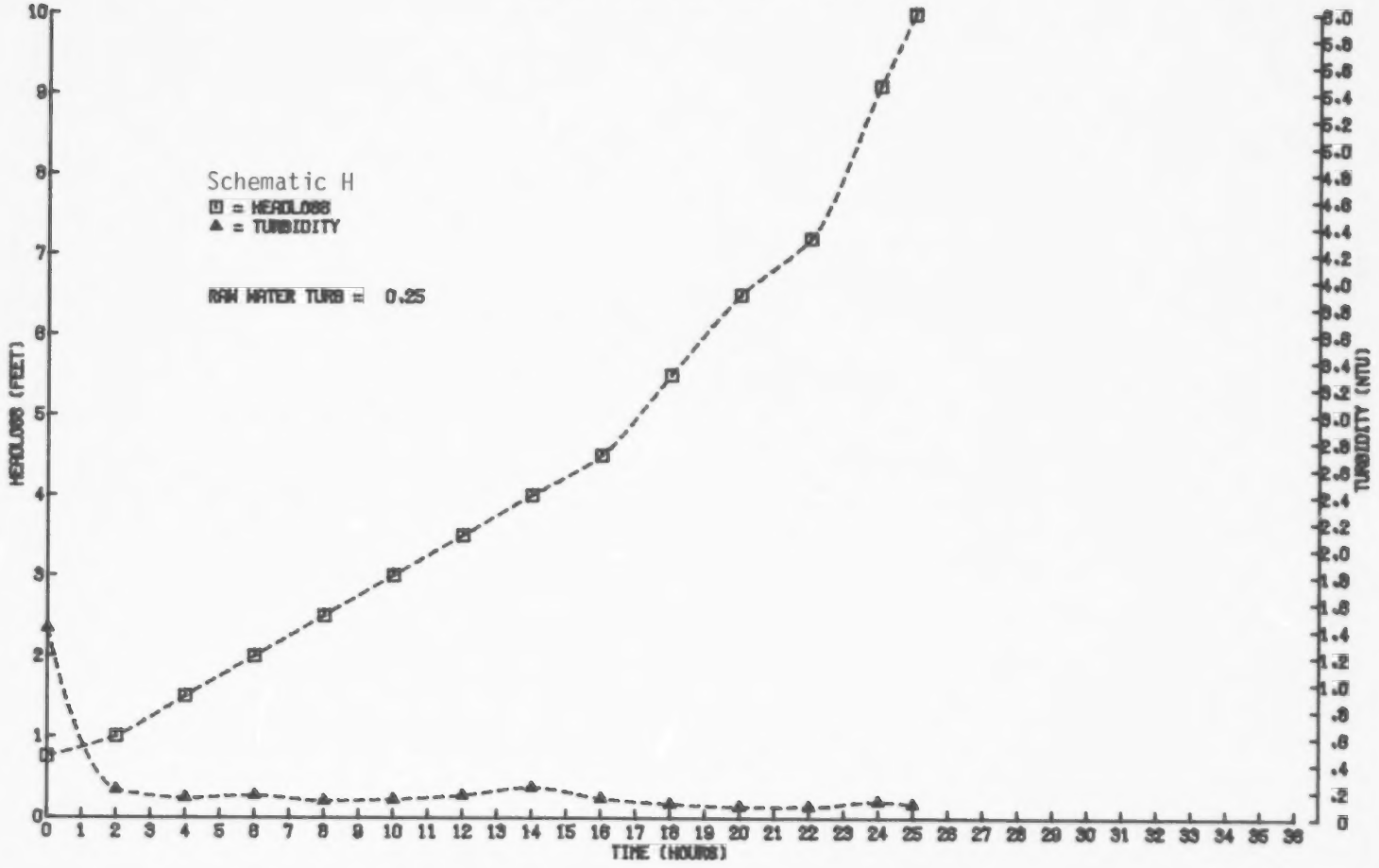
RUN NUMBER 163CC



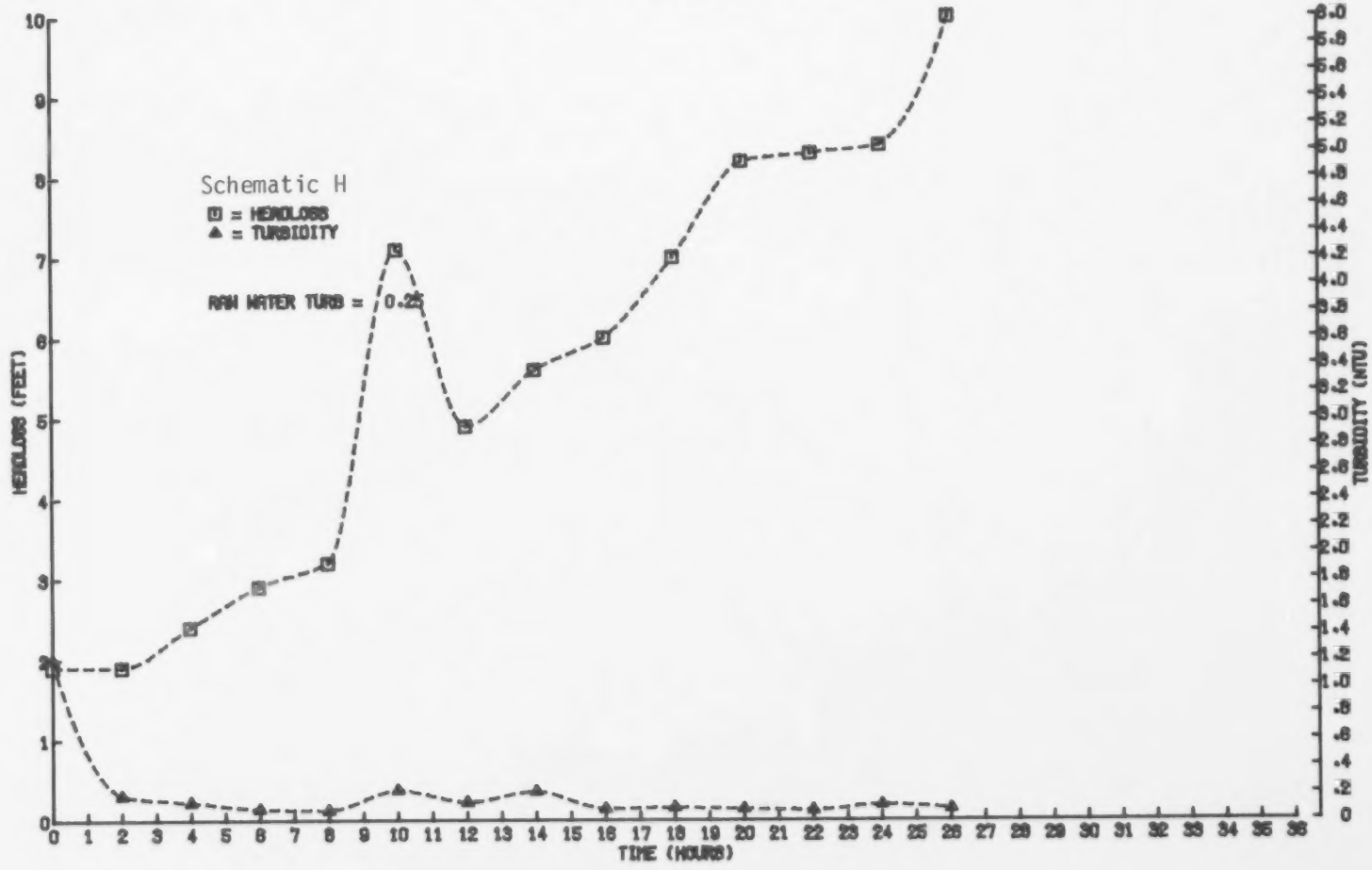
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 168



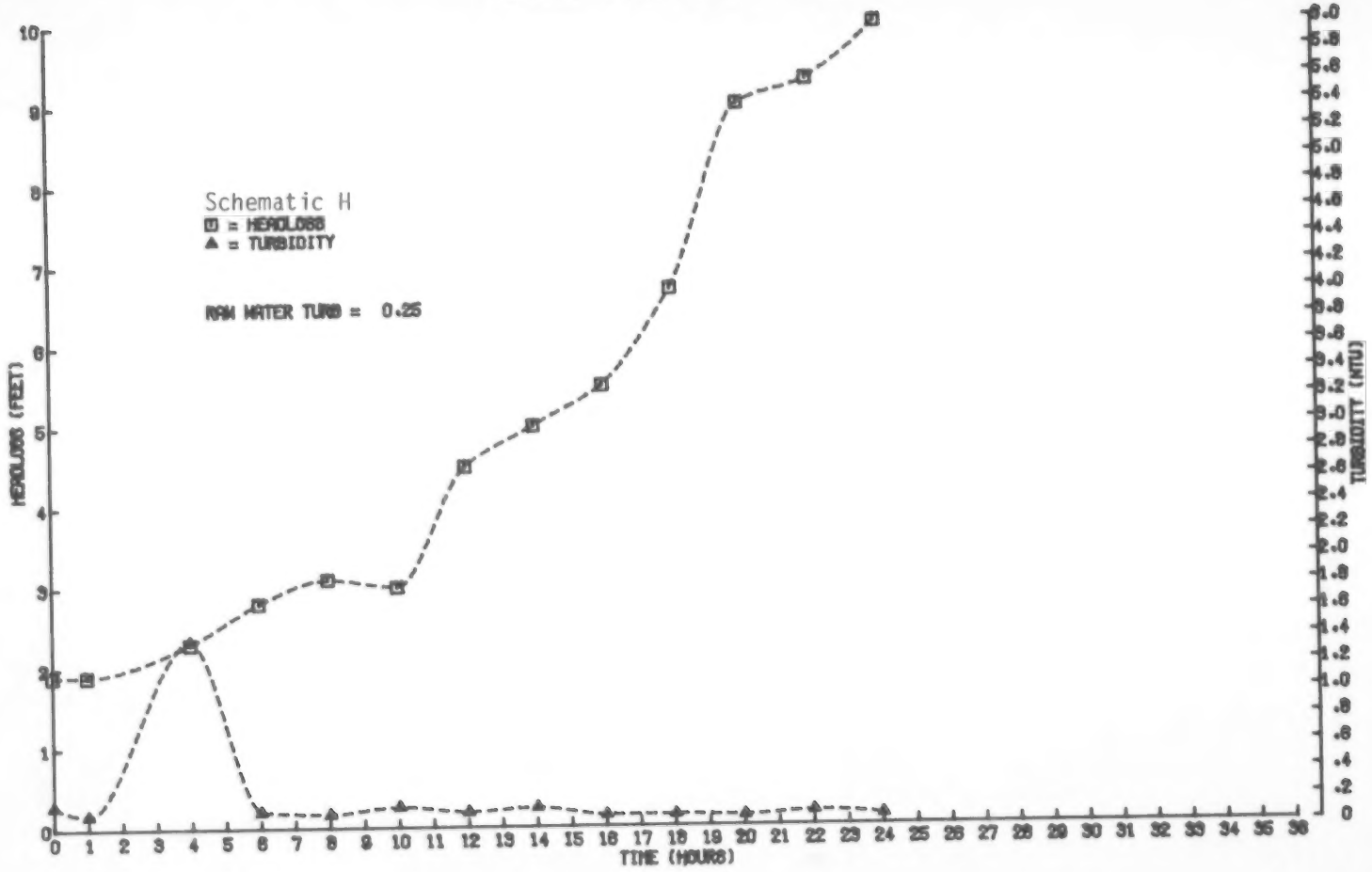
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 168M



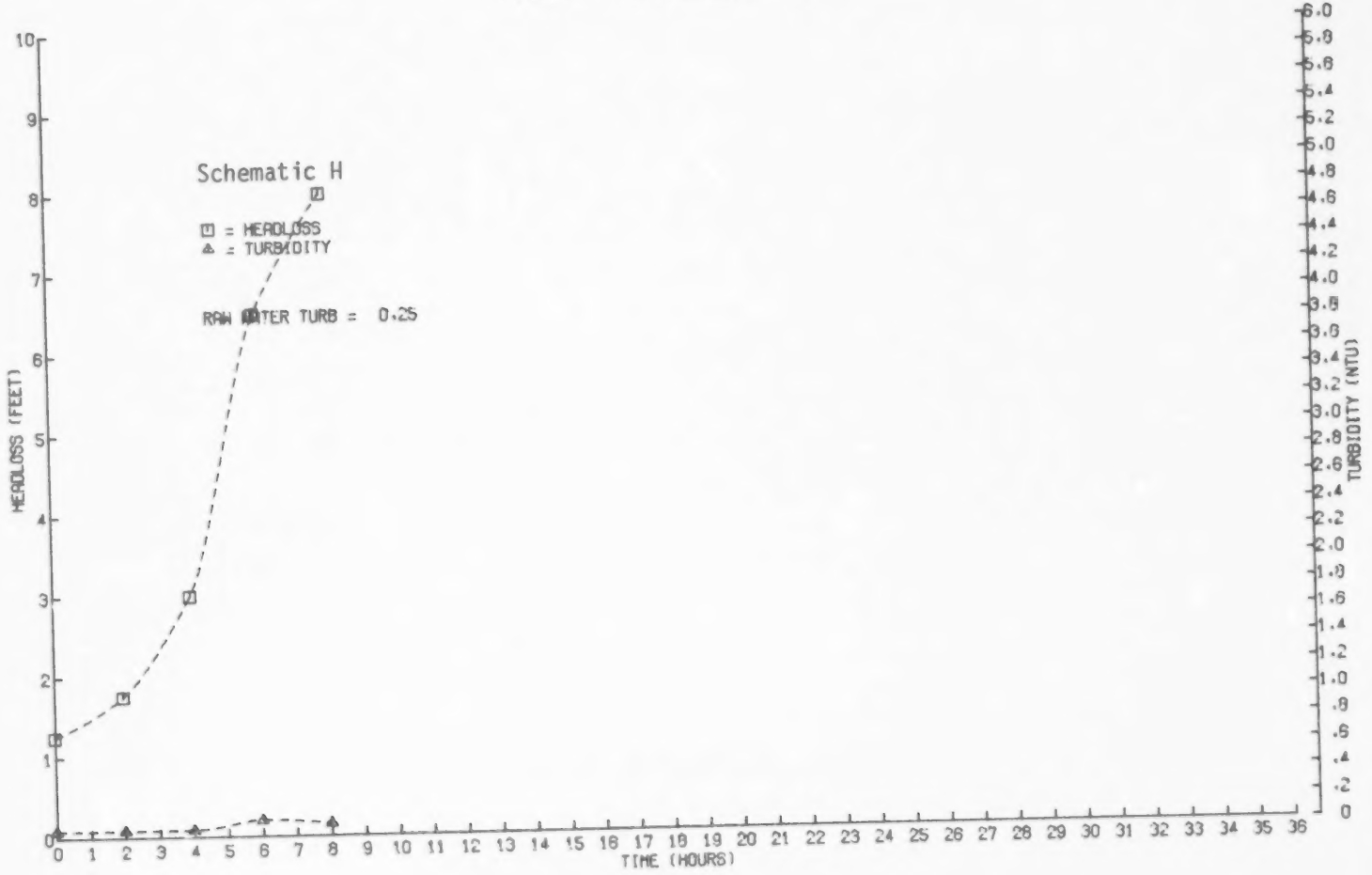
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 168F



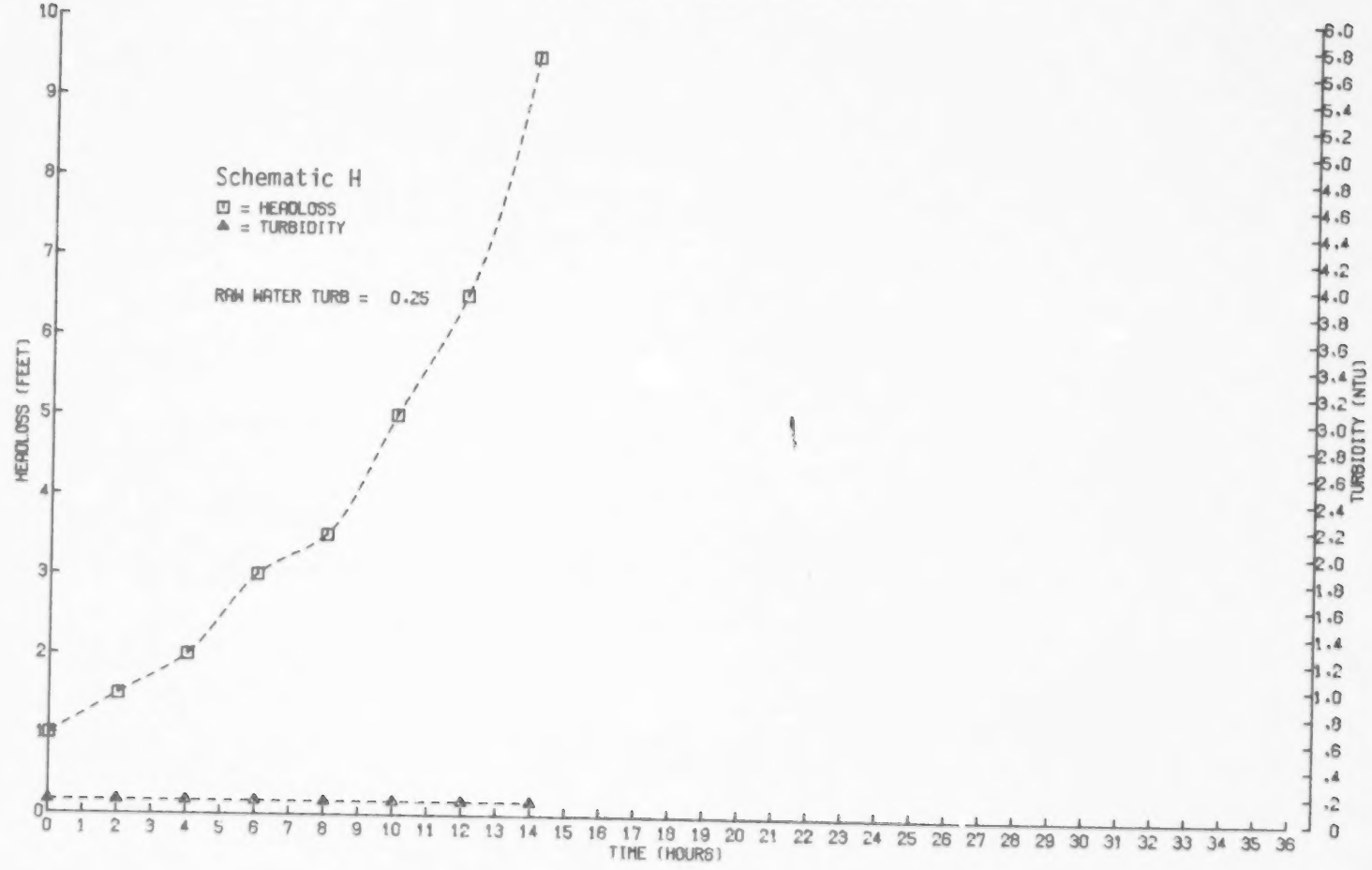
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 168C



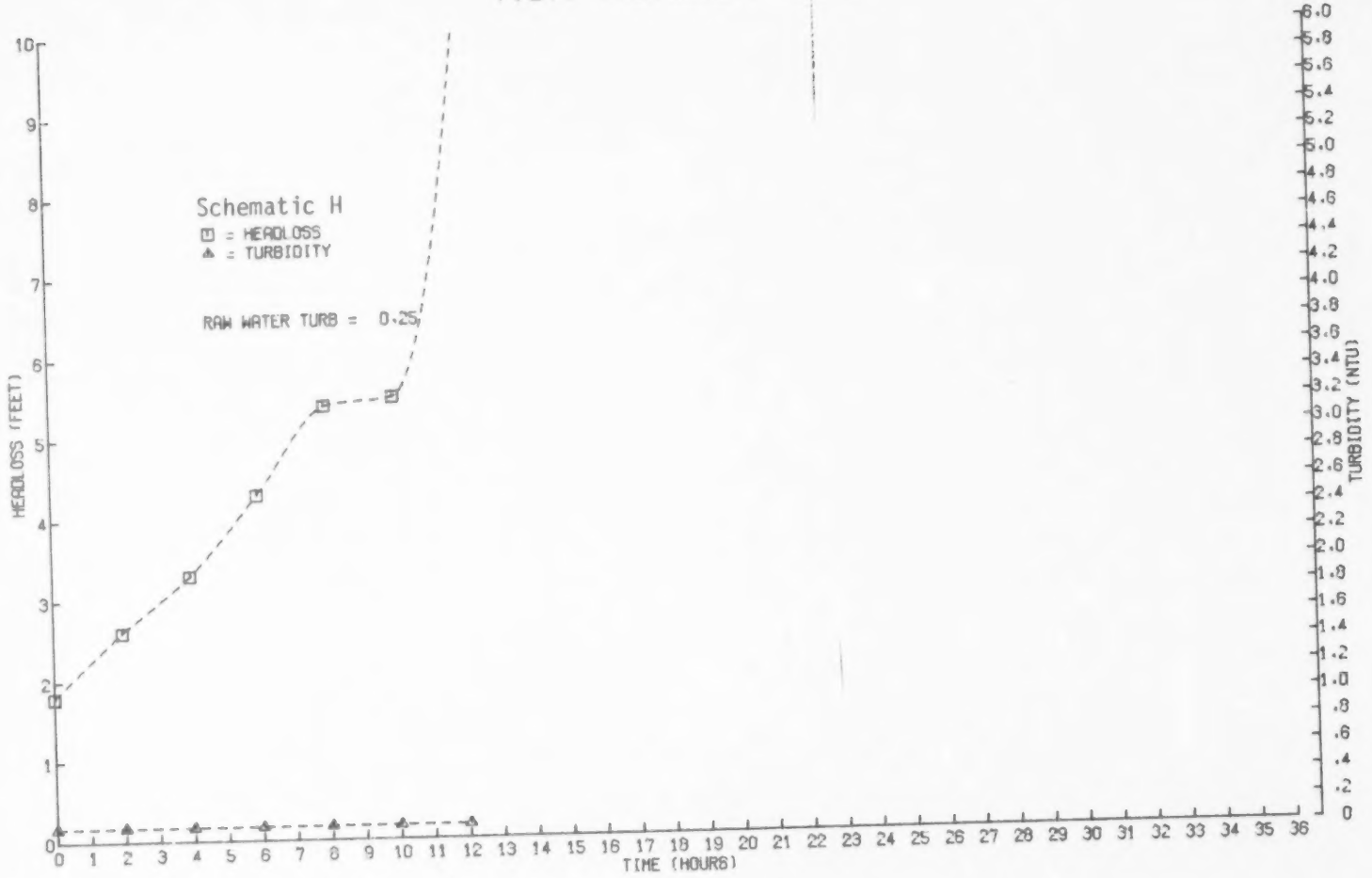
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 169



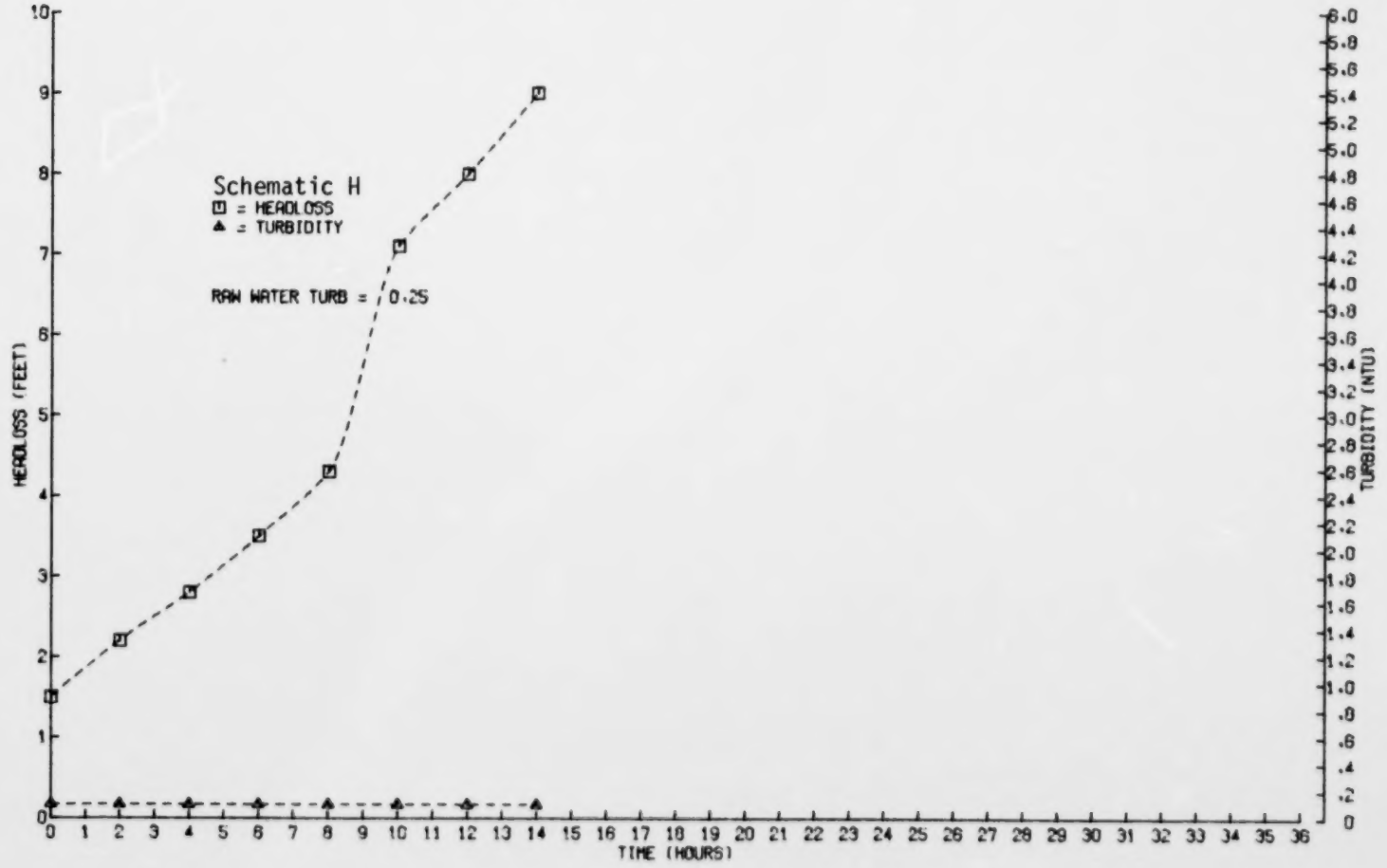
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 169M



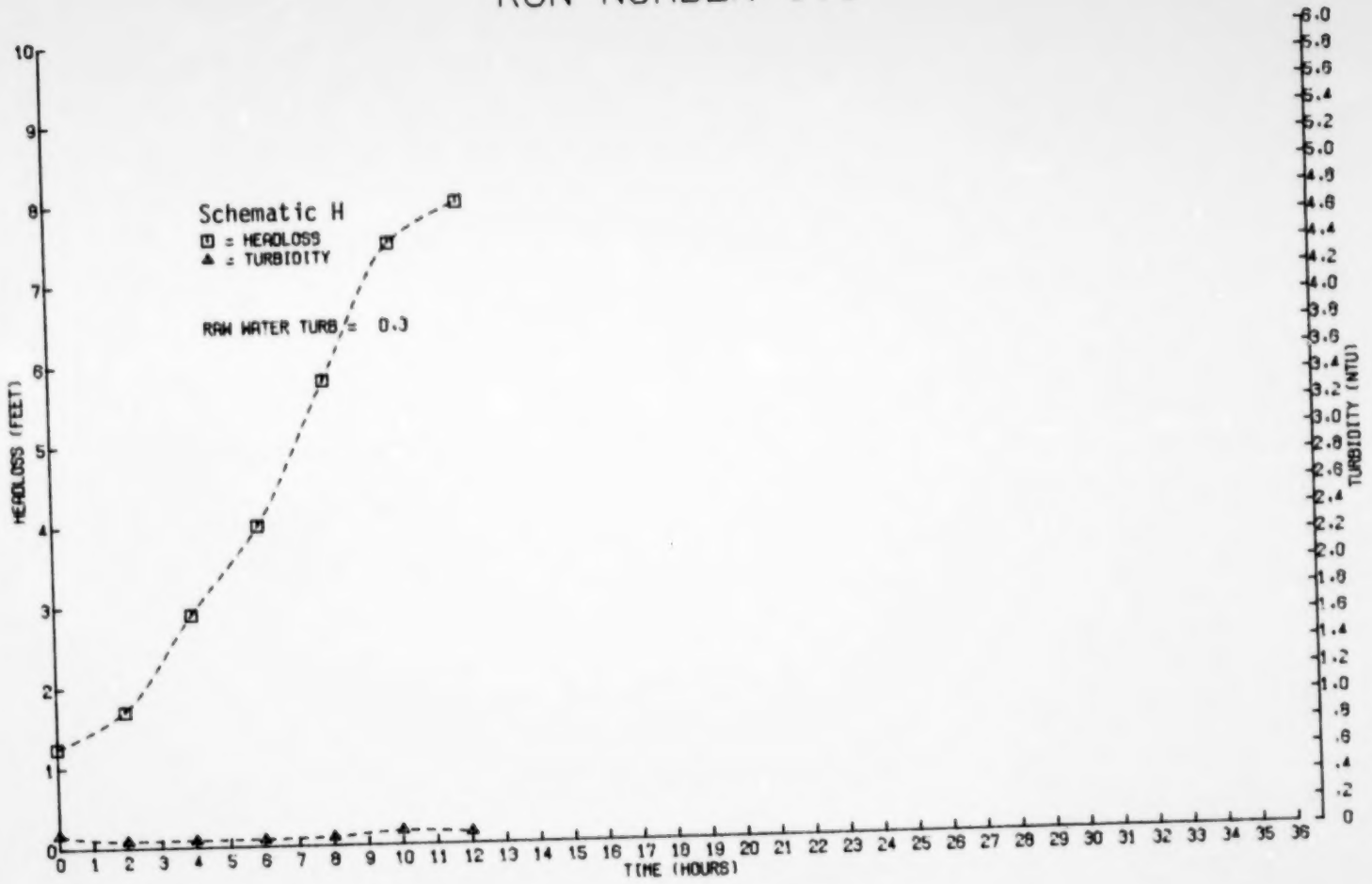
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 169F



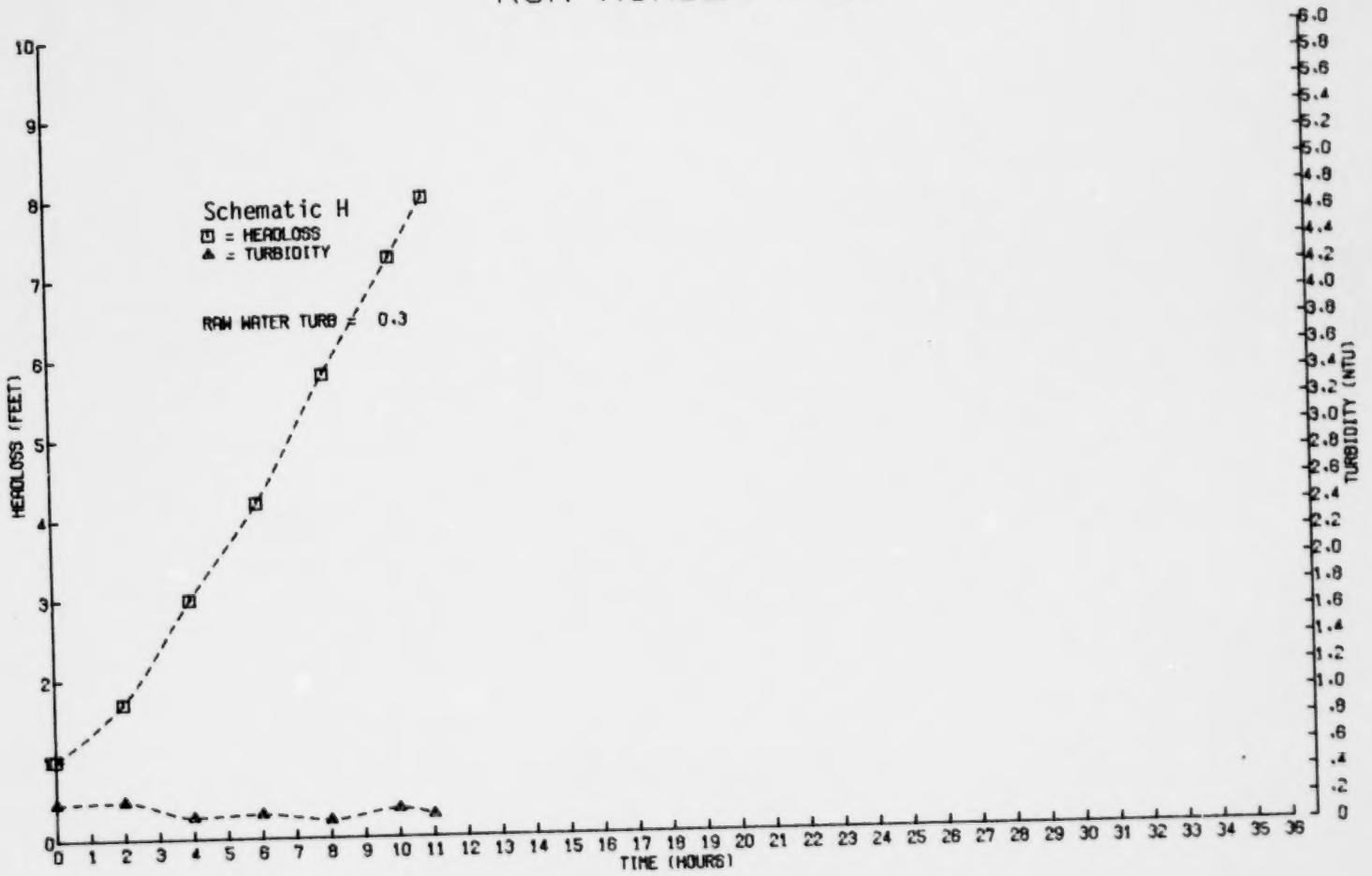
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 169C



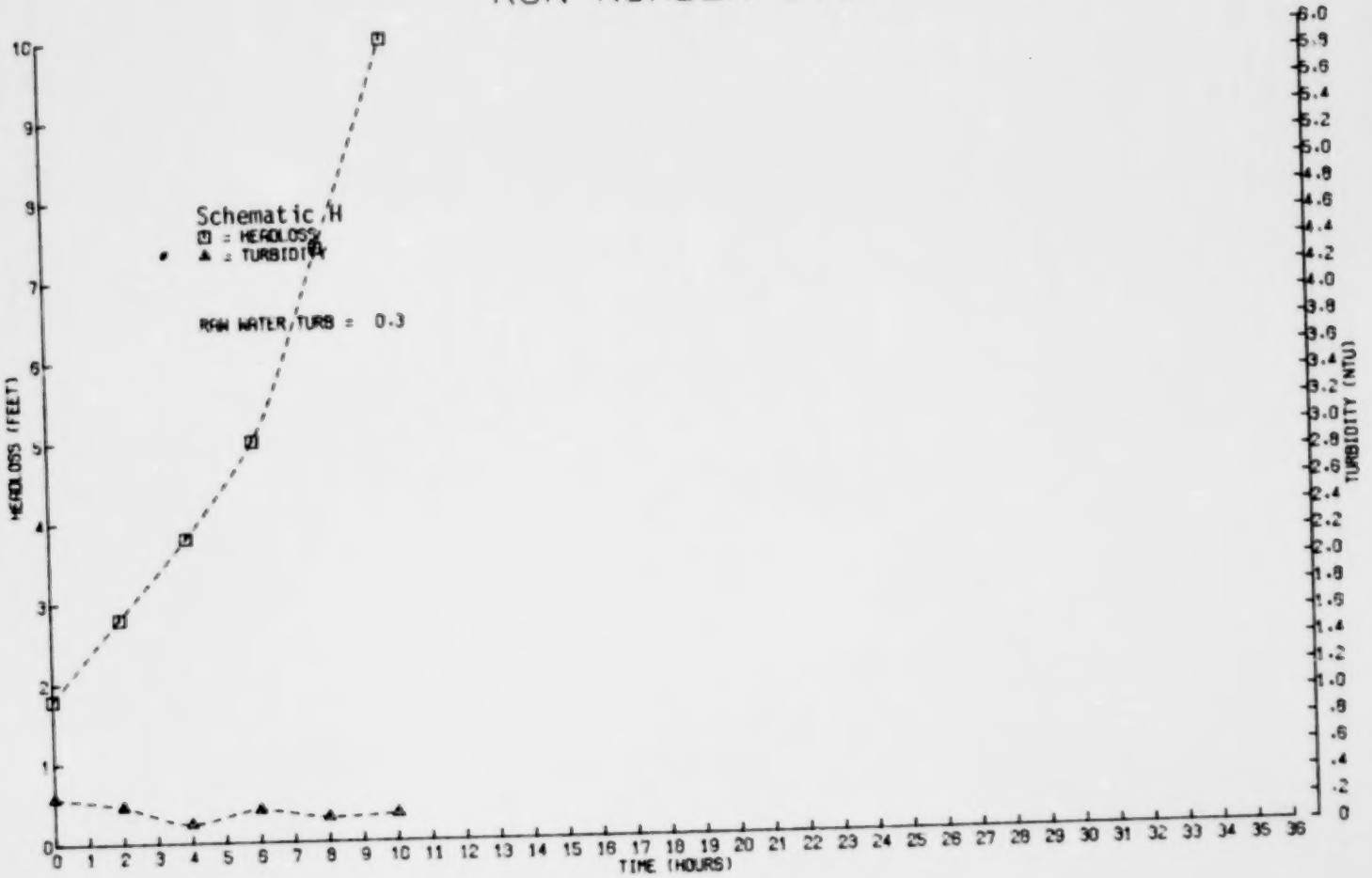
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 170



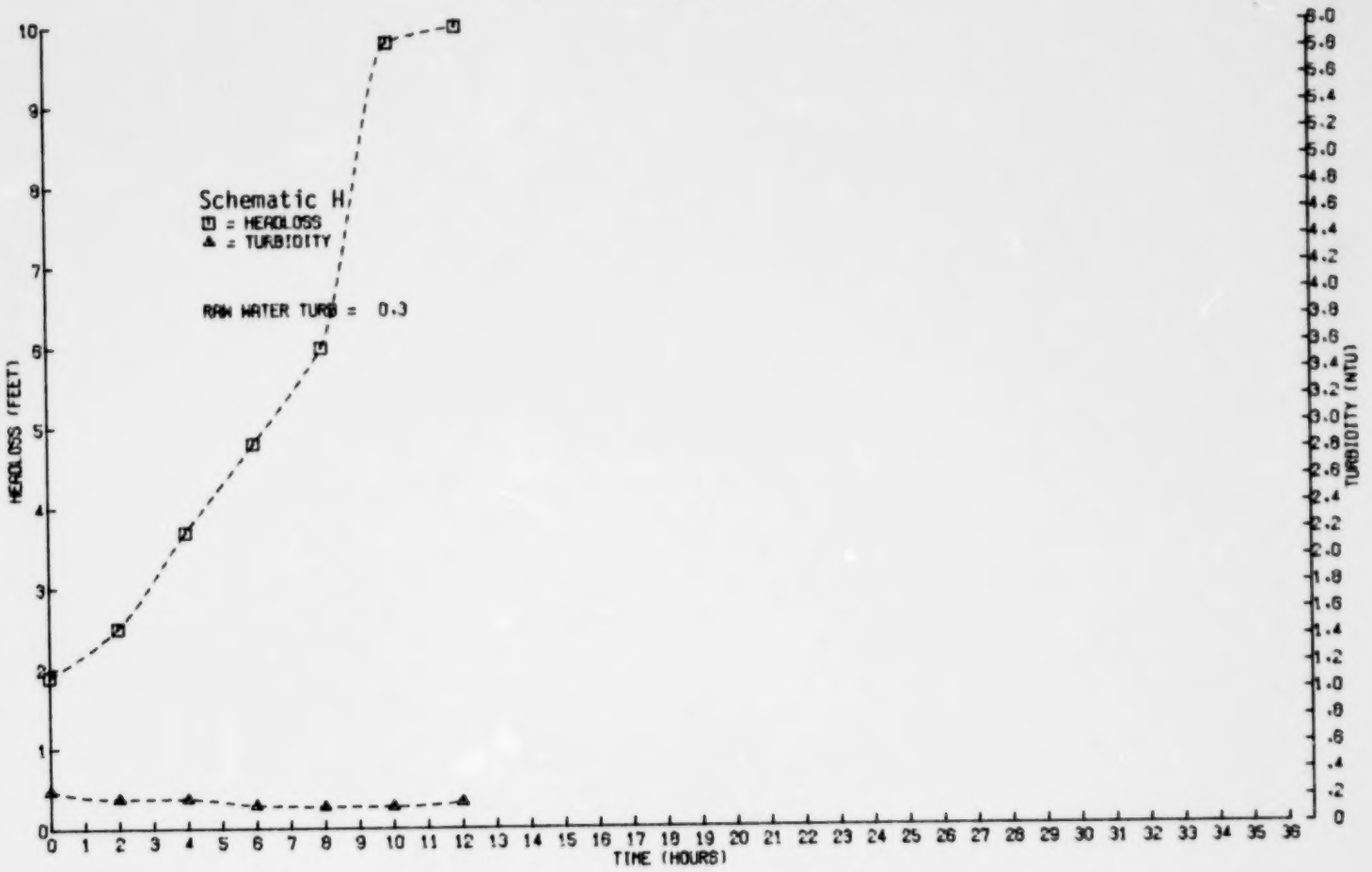
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 170M



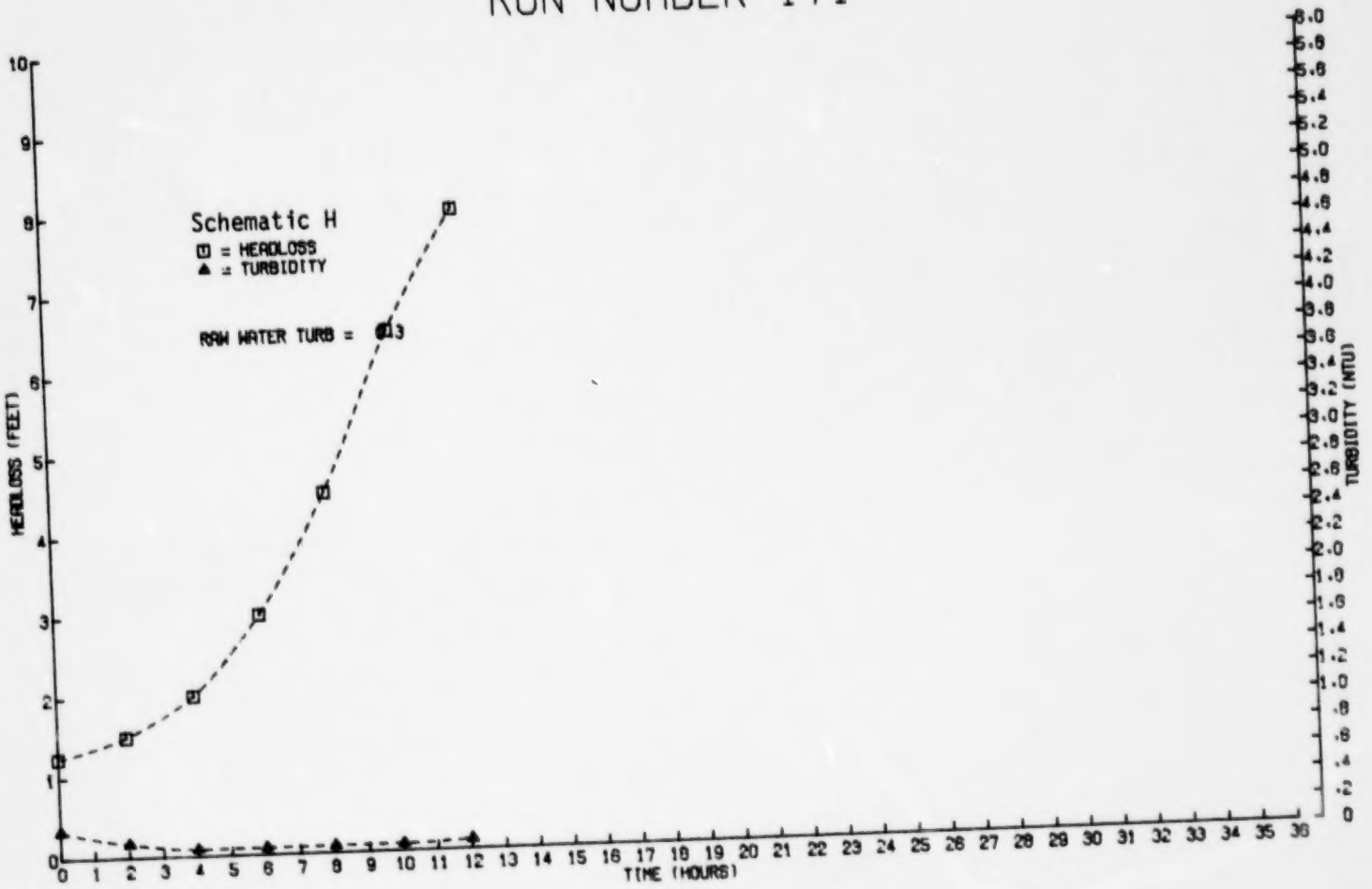
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 170F



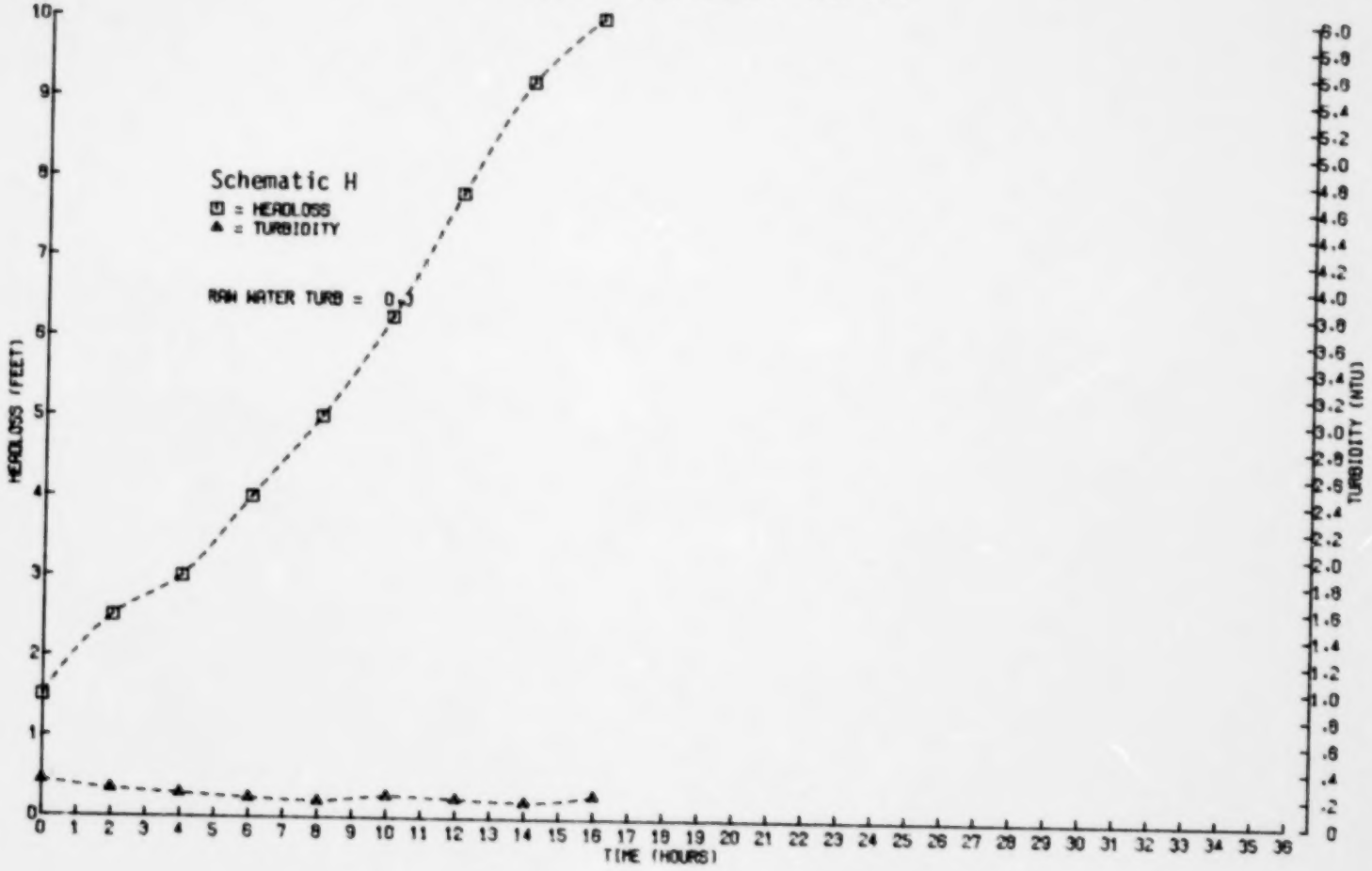
HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 170C



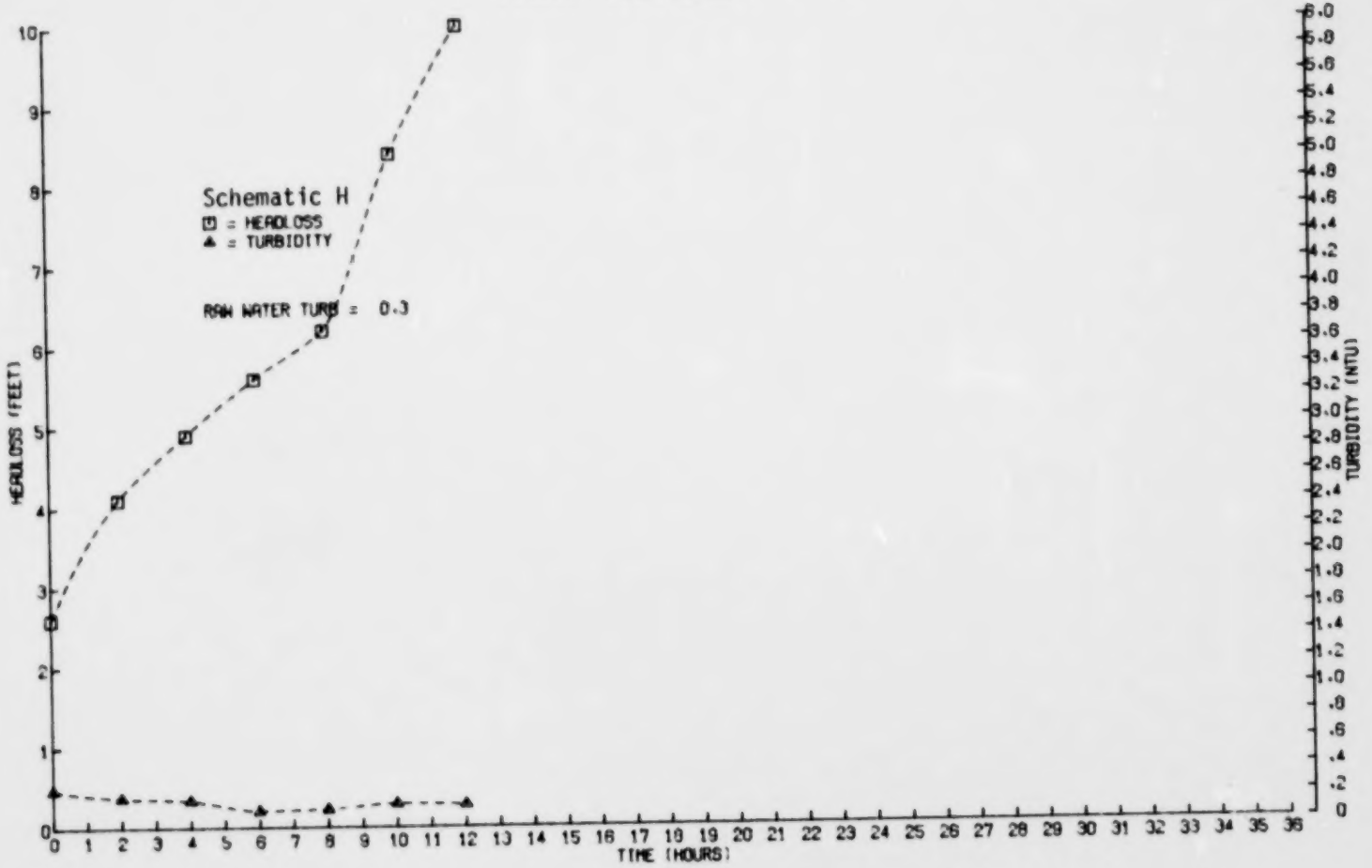
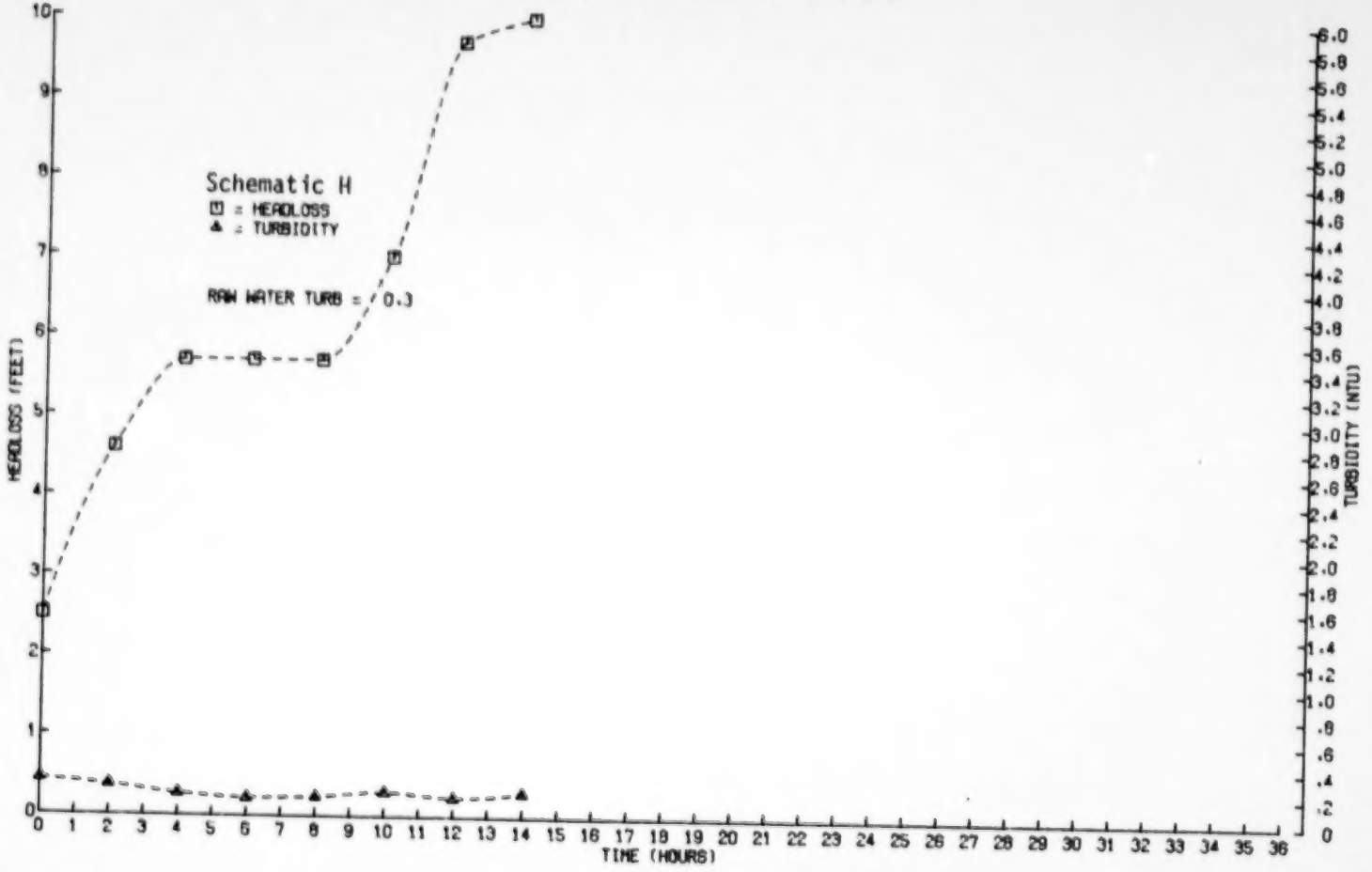
HEADLOSS AND TURBIDITY
VS TIME
RUN NUMBER 171



HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 171M



HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 171F



HEADLOSS AND TURBIDITY VS TIME RUN NUMBER 171C